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The Improvement of Native Food Crops

The greatest agricultural problem in the native areas of tropical Africa is the maintenance of soil fertility, after which in order of urgency one can certainly rank the improvement of native food crops. Most of these have, as far as we know, existed in their present state from time immemorial and need only the application of straight-forward scientific method to improve them. In the past the work of plant-breeders in the tropics has been concentrated for the most part on improving the yield and quality of cash crops, such as cotton and tobacco, because these matters were felt to be of greater urgency than the amelioration of food crops which appeared satisfactory and about which there were no complaints. However, in recent years it has become increasingly evident, largely through the study of native diet, that there is a real need for an improvement in the yield, quality and variety of native food crops, particularly in districts where the African is suffering from forms of malnutrition known to be due to lack of variety in his diet or to its low food value.

The breeding of better food crops from the existing unimproved material should be a comparatively easy task for the

experienced plant-breeder and appears to offer unlimited possibilities. But the problem is not generally found to be an easy one in practice as the breeder must change his scale of values and try to think in terms of the native cultivator, with his limited resources, as well as in terms of the modern scientist. For instance, whereas the European breeder or farmer usually gives increased yield or better quality first consideration, the African peasant, who is not normally limited by shortage of land, puts a higher value on such characters as ease of cultivation, ability to tolerate mixed cultivation, keeping qualities, or resistance to birds in the field and weevils in the store. In theory there is no reason why such characters should not be combined with high yield and good quality by the skilled plant-breeder, but they complicate the problem and add considerably to the time necessary to achieve success.

One of the chief difficulties confronting the plant-breeder in tropical Africa is the prejudice of natives, chiefly the women, to any new form of food; even a slight difference in colour or texture in an improved local crop is strongly objected to at first. For this reason progress is tedious but the breeder may take comfort by recalling similar prejudices in European countries; for instance the early prejudice against potatoes when first introduced into Scotland, because they are not mentioned in the Bible. Because of this conservatism on the part of the African it is a wise policy to concentrate in the early stages on the amelioration of existing local varieties, or on the introduction of closely similar types, rather than to attempt the introduction, on a large scale, of new, and often strange, foodstuffs, however promising they may appear.

After the improvement of existing food crops comes the introduction of desirable new ones from abroad, particularly pulses of high protein and fat content; but the introduction of such new foods to natives is not easy as the African, although critical of his food, is no gourmet and will quite happily eat the same frugal, monotonous diet day in and day out without question. What, for instance, could be more unattractive, or less nourishing, than the cassava diet of some tribes? In fact the diet of most Africans, East and West, would appear by European standards to be very limited in variety and quantity compared with, say, that of the Indian or Javanese peasant.

The main object of the plant-breeder working on native food crops is to improve the welfare and general health of the African; and in this respect he can probably achieve more than a follower of any other profession because his improvements are not dependent on the provision of a large staff nor on constant after-contact with the people over a large area. The powers of the plant-breeder are, however, limited in one important respect as no amount of crop improvement can remedy the deficiency due to lack of animal protein in native diet, except indirectly by increasing crop yields per acre, thus enabling the native to purchase more animal food. Because of this need for animal protein any programme for the improvement of native food crops by breeding and selection needs to be related to the work that is being done by Medical and other departments for the improvement of native diet if the necessary changes are to be wrought. Not only do existing crops need improving but a greater range of crops is needed, and, as a corollary, Africans will need to be educated to eat new and better foods. This change may take a generation to

achieve, but that it can be made becomes evident in case of famine or other necessity. This was brought to the notice of the writer in a rice-eating country where prisoners on entering jail were suddenly put onto a maize diet, for reasons of economy, and in the end grew to prefer this food and continued to eat it after their discharge from prison. Peasant settlement schemes, such as that at Kingolwira in Tanganyika, may well serve as the link between the dietician and the native farmer and bring about the change as a gradual and natural process.

The improvement of native food crops by breeding, selection or introduction is being carried on by all the East African Agricultural Departments at the present time as far as limitations of staff allow. The subject has also been added recently to the research programme of the East African Agricultural Research Station, Amani. An interesting article on the work being carried on in Eastern Uganda, written by H. R. Hosking, appears in this number and will give readers an insight into the type of plant-breeding work that is being carried out in that dependency. We also publish an article on Food Crops and Food Shortages, by N. Humphrey, which describes the excellent type of work being done to improve the food-crop position in the Coastal Districts of Kenya. In this article the author refers to the interesting conversion from small grain cereals to maize that has taken place in recent years and discusses the reasons for this change and its undesirable features.

A. G. H.

The Improvement of Native Food Crop Production by Selection and Breeding in Uganda

By H. R. HOSKING, *B.Sc.(Lond.), A.R.C.S., A.I.C.T.A., Botanist, Department of Agriculture, Uganda*

The question of improving native food crops is beset with difficulties. With long established crops it is probably true to say that the native can teach us more than we can teach him. With newly introduced food crops, however, the position is reversed.

Detailed agricultural-medical surveys are being undertaken in the Eastern Area to determine the relationship between health and the diet and agricultural practice of the natives. When the results of these are available we should be in a better position to state that such and such crops could well be introduced into certain districts. One of the greatest difficulties is to overcome native custom where his food is concerned. On the whole, the grain-eating and cassava-eating tribes suffer from nutritional deficiency diseases; largely ascribable to the lack of animal protein. To make any real progress not only must we introduce crops of higher food value, but at the same time the native must be educated to eat more meat. This is a wide question and one which it is impossible to discuss here.

Eleusine coracana (Finger Millet).

This forms the staple food crop for large areas east of the Nile, notably in North Busoga, Budama, Bugwere, those parts of Bugishu lying below the 5,000-foot contour, Teso, Lango and parts of Acholi. The crop is planted by broadcasting either the standing cotton or on a specially prepared plot. The greater part of the crop is planted before the break of the rains in mid-March and is harvested normally in July.

A large number of varieties are known to the natives; some are grown entirely for the production of beer, some are used only for food, and others can be used for both food and beer. It is pointless to give a list of names as the commoner varieties have different names from district to district, and in Teso for example, different names in different parts of the same district.

When used for food the grain is first ground into a meal with the usual type of stones found in native villages all over East Africa. It is then cooked and eaten as a porridge. When available, relishes and such foods as sweet potato flour, groundnuts, and sim-sim are added to relieve the monotony. Beer is made from fresh or stored grain. It is first of all germinated, mixed with germinated sorghum, and then the two are made into a flour. The flour is steeped in water for about fourteen days and then evaporated over a fire. The residue is dried in the sun for one day and then put into water with a small quantity of yeast (usually old beer) and allowed to ferment for three days. The beer should be drunk within five days, or it becomes bitter and is considered spoiled.

Selection work is concentrated on the following points:—

(*a*) Production of high-yielding early-maturing varieties.
(*b*) Resistance to rice blast.
(*c*) Resistance to drought.
(*d*) Strong straw.

So far little progress has been made—the work started three years ago—except that a knowledge of the yielding capabili-

ties of the various varieties has been accumulated. Although rigid selection against rice blast has been done for the whole of this period there is little evidence of resistance.

Work on this crop is complicated by the local preferences of the different tribes, and also by what is known locally as the "*Ekitu* problem". *Ekitu* (Teso) is a weed which occurs in Eleusine plots in varying amounts according to the conditions. Until it flowers it is very hard to distinguish from proper finger millet. At one time it was thought to be sterile millet but the writer has shown that it grows readily from seed. Attempts are now being made to cross true millet with *Ekitu* as it is still uncertain whether it is a degenerate form of Eleusine or a separate species. Last year (1937) the whole of the breeding plot which was planted from single heads of specially selected plants came up as *Ekitu*. The reason for this is as yet unknown.

The nutritive value of Eleusine flour is not high; an average sample contains about 7 per cent of crude protein, about 1 per cent to 1.3 per cent fat, 0.4 per cent CaO and 0.7 per cent P_2O_5. Even so it is a considerably better food than cassava. Unless the ration of millet flour is augmented by animal protein, milk, pulses, and green vegetables, vitamin deficiency diseases will result. It is probably true to say that millet beer is better from the nutrition point of view than millet porridge.

One of the outstanding advantages of finger millet is its long storing property. It can be stored up to seven years and still make eatable porridge. It is practically immune to weevils, etc., when in store.

Sorghum.

The cultivation of Sorghum increases as one goes northwards in Uganda. In South Teso it is grown chiefly for beer making, whereas in North Teso, Lango and Acholi it forms an important part of the native's diet.

A large number of varieties (well over one hundred) have been collected and grown at Serere.

Selection work is conducted with two aims:—

(*a*) Production of high yielding food varieties.

(*b*) Selection of strains suitable for silage for cattle feed.

The chief disadvantage of sorghum as compared with finger millet is the great difficulty experienced in keeping the stored grain free from weevils and moths. A certain number of strains reported to be weevil-resistant in Tanganyika have been tried, but at Serere they have not proved resistant to weevils when in store. It has been found that lime helps to keep down the weevils and moths to a certain extent, but even then a considerable portion of the grain is damaged severely. A further difficulty is the danger of loss of crop in the field due to depredations of small birds, doves, etc. The hard-grained varieties are not so badly attacked, but the sweet soft-grained varieties, as they ripen, need a constant guard to ward off the birds.

In a preliminary variety trial conducted at Serere in 1937 one of the Teso strains known as Kitirima proved the highest yielder. This is a short-strawed variety and is only slightly attacked by the birds. The grain is reddish-brown in colour, and the threshing percentage is high, being 78 per cent. A few experiments have been done in the past, which have shown that a seed rate of 16 lb. per acre, broadcasted, is approximately the best.

Sorghum is one of the food crops that can be planted during the second half

of the year in Bugwere, Teso, Lango and Acholi districts. Its food value is superior to finger millet since it contains anything up to 12 per cent crude protein and about 4 per cent fat; its CaO and P_2O_5 content are approximately the same as in finger millet. However, the tribes which use sorghum as their staple diet, with little to supplement it, commonly suffer from deficiency diseases. As a food crop to be eaten within six months of harvest it is to be encouraged, but owing to its poor storing qualities it can never take the place of finger millet as a crop to be stored against famine. The planting of sorghum in the second rains is encouraged in Teso as it gives the natives a food to carry over the dry season without having to fall back on their reserves of finger millet.

Groundnuts (*Arachis hypogaea*).

In certain of the light soil areas, notably of Bugwere, Teso and Lango Districts, this is an important food crop, and it is becoming increasingly important as an economic crop. Formerly only the spreading type was grown, but the native is tending to grow an increasing proportion of the bunch type, chiefly because the latter requires considerably less labour to harvest. The crop is sown by broadcasting the seed. The spreading type takes about four months from sowing to harvest, and the bunch about three weeks less.

Selection work is carried out with both bunch and spreading types because the relative yields of the two types vary from season to season. The chief aim is to produce high-yielding strains, resistant to rosette disease, with high shelling outturn. While it must be admitted that under native conditions of cultivation rosette disease seldom assumes serious proportions it has been the policy to select only those plants free from the disease for the last four seasons. It is highly probable that complete or even partial resistance does not exist.

The answer to the rosette problem has been found in the methods of cultivation. If very close spacing is used then little rosette will result. A far more insidious pest—because not obvious until the crop is harvested—is a small ant which bores into the pods while they are still underground and eats the developing seed. The proper name of this ant is not known but only in exceptional seasons does it cause serious damage in the light sandy soils. *Cercospora* leaf spot usually defoliates the plants as they ripen, but so far has done little damage to the crop in its early stages.

Extensive experiments have been conducted for the past half-dozen years to determine the effect of mulching, the most suitable spacing, the best type of cultivation, etc. Selection work has resulted in increased yield, but owing to the uncertain behaviour of the two types, it is difficult to say whether any particular strain is the best because in some seasons the spreading types will do better than the bunch. The most promising bunch selection so far obtained is derived from the South African Spanish No. 68/6. The nut is very small, round in shape, and has a pale pinkish-brown skin. The shelling out-turn is low but despite this it gives a good yield.

On the whole yields in the so-called groundnut areas are low when compared with other countries. It is seldom that 1,000 lb. per acre in the shell is surpassed and under native conditions a fair yield is probably in the neighbourhood of 600–700 lb. per acre unshelled.

The cultivation of this crop is encouraged wherever it gives an economic yield because of its high nutritive value. A

Uganda sample of fresh groundnuts has given the following analysis: Crude protein, 22.87 per cent; Fat, 49.19 per cent; CaO 0.09 per cent and P_2O_5 1.02 per cent. The natives are extremely fond of groundnuts since they break the monotony of their millet diet.

Cassava.

It has been the policy of Government to encourage the planting of cassava as a famine reserve in the grain areas. The Director of Medical and Sanitary Services has recently stated that his department did not view with favour too much encouragement of this crop. In Northern Rhodesia it has been found that the millet-eating tribes have a distinct advantage over cassava-eating ones because millet contains five or six times as much protein, fat, calcium and phosphorus as cassava, and twice as much iron. A sample of fresh cassava from Uganda gave 1.50 per cent crude protein, 0.40 per cent fat, 0.04 per cent CaO and 0.17 P_2O_5. Dried cassava from Northern Rhodesia gave a very similar analysis. It can be seen therefore that, judged by analyses, cassava is one of the poorest of the native food crops.

A collection of varieties from different sources is being grown at Serere. Variety trials are conducted with the more promising strains, observations being recorded on susceptibility to mosaic disease, time to ripen, yield and palatability.

Pulses and Miscellaneous Crops.

Apart from *Vigna catjang* and *Cajanus indicus* the natives living in the greater part of the districts east of the Nile are very short of pulses to balance their grain diet. For this reason an attempt is being made to popularize such beans as *Canavalia ensiformis, Stizolobium* and Soya Beans through the medium of the Native Administration Prison Farms.

In Teso District these Prisons are now self-contained in that they grow their own food on farms laid out and controlled by the Administrative and Agricultural Officers. Only short-term prisoners are detained in these jails. The rotation is based on eight seven-acre plots. In any one year twenty-eight acres are planted with food crops in the following proportions: fourteen acres of early sown finger millet, three-and-a-half acres of early sown groundnuts, three-and-a-half acres of early sown sweet potatoes, three-and-a-half acres of the same crop late sown, three-and-a-half acres of early sown soya beans, seven acres of late sown beans (half *Stizolobium* and half *Canavalia*), and seven acres of late sown sorghum. Under normal conditions this gives a reasonably balanced diet (except that it is lacking in animal protein) for sixty prisoners throughout the year. They are able to collect a certain amount of wild plants for use as green vegetables and they also use the sweet potato tops for the same purpose.

A strain of soya bean was imported from the Imperial College of Tropical Agriculture, Trinidad, three years ago. They are a large white bean which originated from Venezuela, and have given good yields under Teso conditions. They are very popular with natives as food and it is hoped to increase them for general distribution. The food value of these beans is high since they contain between 30 per cent and 40 per cent of crude protein and about 17 per cent of fat.

Canavalia ensiformis is a good food, and provided the beans are well soaked and skinned before cooking, it forms a valuable addition to the diet. The yields of this crop when planted in the early rains are good, running up to half-a-ton per acre.

Stizolobium gives similar yields to *Canavalia.* It has not proved so popular as a food, although it may when the native is used to it and has learnt how to cook it properly.

Vigna catjang is a very popular food crop because not only does it produce a good bean but the leaves are used as a green vegetable. Unfortunately the yields are usually very low. It is cultivated fairly extensively in Teso, Bugwere and Budama districts. No selection work has been done on this crop at Serere to date.

In Lango *Cajanus indicus* is a popular food—it is comparatively rare outside the Northern Province. The bushes are allowed to grow for three years and are picked repeatedly.

Sesame is a crop which needs special soil and climate. The natives usually know where it can be grown successfully. Selection work is being done only at Bukalasa on this crop.

Sweet potatoes are a popular crop, of which a large acreage is usually planted in the late rains. The larger portion of the crop is split, dried and eaten as a porridge after grinding. No work on this crop is being done in the Eastern area.

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The Utilization of Sisal Waste in Java and Sumatra—Part II*

By J. E. A. DEN DOOP, *Bandoeng, Java*

In the first part of this article the fuel value of sisal waste was discussed extensively and it was further shown that under Java and Sumatra conditions it must in general be more economic to use the sisal waste as manure than as fuel, although possible exceptions were not excluded.

In the following parts the author will discuss his experimental and practical experience with the utilization of sisal waste, inclusive of sisal stumps, as manure, on the basis of a sufficient knowledge of the soil to which the waste was applied.

It may be useful to show straight away that such utilization has at present gained some practical importance in the Dutch East Indies by the following quotation from the chairman's speech at the twenty-seventh ordinary general meeting of the "Anglo-Dutch Plantations of Java, Ltd.", held in London on 24th July, 1937, regarding this company's Java estate "Soekamandi", which is a sisal and tapioca estate.

> "Aqueous manuring was also continued, 1,419 acres being treated in this way throughout the year. Since a start was made with aqueous manuring in 1930, 6,771 acres have been treated with considerable benefit to the crops at a comparatively low expenditure."

It should be explained here that "aqueous manuring" in this quotation means inundation of the cleared old sisal or tapioca fields, which have to be converted into new sisal fields, with "waste water" plus "free tissue", these expressions being applied here in the way defined in the first part of this article. "Aqueous manuring" thus can be repeated on the same land only once before every full sisal cycle, i.e. under the conditions of the above quotation, once in about eight years. This period of eight years will however, for the estate concerned, soon be shortened to seven years and later perhaps to six years, as the result of improvement of soil fertility by combined "aqueous" and artificial manuring. That is, the more fertile the soil in which the sisal grows, the shorter its cycle, whereas the shorter the cycle becomes through increased soil fertility, the greater the increase on the total "fibre" production during the cycle.

Thanks to the kindness of the representative in Java of the Anglo-Dutch Plantation of Java, Limited, the author may relate here the story of this "aqueous manuring".

This may contribute to a better understanding by the various workers, interested in sisal elsewhere, of the status of sisal research work and other knowledge in the Dutch East Indies, where in some sisal quarters a strong tendency exists in favour of complete secrecy regarding sisal knowledge. The desirability from a general point of view for more publicity in this respect may be seen from the following example, derived from the 1933 volume of *Der Tropenpflanzer*, a journal which in the past has contained various important sisal publications. In 1933, when in the Dutch East Indies every

*The East Indian conditions described in this part are compared with those of East Africa in a note by Mr. W. E. Calton at the end of the article.

Part I appeared in this Journal, Vol. III, No. 6, pp. 423-438.

important aspect of sisal waste utilization as "waste fibre", as "fuel" and as "manure" had been studied and had been practised, although not generally, Dr. Richard Hindorf, the pioneer sisal planter of East Africa, contributed an article to the above journal, entitled according to English translation: "Why don't we advance with the utilization of sisal waste?"

Although the title of Hindorf's article typifies his opinion about the 1933 position of sisal waste utilization rather clearly, a few quotations from his article, translated in English, may further elucidate this:—

> "The first idea presumably has been to carry the sisal leaf waste at once back to the fields, with a view to spreading it there between the harvested (*abgeernte*) Agave-plants and of working it under. It has also frequently been tried to burn the waste after some preliminary drying or to compost it, with a view to using the ash and the compost afterwards as manure. In practice such utilization was opposed however by obstacles which were difficult to surmount. . . Presumably great difficulties will never be met with nor high costs incurred on sisal estates, by conducting the "pressed-out sap" to land depressions or to similar places. This waste sap has no great value. . . In manuring with sisal waste-leaf, on various occasions effects of a harmful nature have manifested themselves simultaneously with the manuring effect, with the result that such manuring has been abandoned entirely."

One sees from these quotations that Hindorf had in 1933 no high appreciation of "pressed-out waste sap", which, as may be deduced from Table I of the first part of the present article, is of the highest manurial value, a fact investigated and applied long before 1933 by the present author. Furthermore Hindorf made a statement regarding the utilization of sisal waste as manure, which was just the opposite of what was happening since 1930 on a large scale on the estate "Soekamandi" in Java, where such utilization was a great success.

Fortunately it appears from recent publications by research workers of the East African Research Station at Amani, that in East Africa no secrecy whatever is preserved with regard to sisal research results, and also the present author has already followed such a publicity policy for some years and intends to continue to do so.[1]

The data to be reported here will chiefly apply to the above-mentioned estate Soekamandi. As a manure, sisal waste is a very complex material and in practice it is impossible to separate it into its various manurial components. Practical and research results with sisal waste as manure thus can never show in what detailed way, say as nitrogen, potassium, etc., such manure has been active. In order to understand its effects well, it is therefore indispensable to describe the Soekamandi soils rather extensively in their agricultural aspects.

Soekamandi estate then should be divided into two parts, which from a pure soil point of view and also agriculturally are very different. The one part is Soekamandi proper, some 14,000 acres, the other part the "outside areas", situated more to the south with a total extension of about half Soekamandi proper. The total sisal area amounts to some 13,000 acres, of which some 3,000 form part of the "outside areas". All the land lies in the coastal plain of the north

[1]Only when the above remarks had already been written, the author received the issue of *Der Tropenpflanzer* of November, 1937, in which Prof. Dr. Th. Marx and Dr. R. Hindorf review at length published data regarding sisal waste utilization. However, no mention of Java or Sumatra work is made in this review and the author's remarks as above remain in full force.

coast of West Java. The northern boundary of Soekamandi proper is only 2½ km. from the sea and it stretches about 15 km. inland, while the most southern parts of the "outside areas" reach to about double this distance from the sea. The elevation of Soekamandi proper gradually rises to about 8 metres above sea-level, while the most southern "outside areas" rise to about 30 metres higher. Soekamandi proper consists of quite flat land with only a little undulation in some parts, whereas the "outside areas" further inland show more undulating forms. These higher "outside areas" with the exception of their most western parts consist chiefly of red soils, which are of quarternary origin and have probably been laid down as mud-streams, the material of which originated from the volcanoes, lying some 40 km. further inland with tops more than 2,000 metres above sea-level. The said red soils form, in accordance with their origin, relatively thin sheets, overlying layers built up from material of tertiary to quarternary origin. This latter type of material gives rise, if exposed, to grey soils. The mud-streams from which the red soils were formed, stopped as a more or less continuous sheet somewhat south of the southern boundary of Soekamandi proper, which as a whole was not covered by these mud-streams. Its soils were chiefly built up from the older material of tertiary to quarternary origin, which gives rise to grey soils. It may be, however, that by the shifting action of river water the grey soil at some places on Soekamandi proper has actually been deposited in its present situation at a date later than when the red soils were formed by the mud-streams. It should also be noted that the mud-streams have deposited some patches of red soil here and there on the sides of the small rivers which cross Soekamandi proper, because the mud-streams did not stop exactly parallel to the sea coast but advanced farther than their general northern limit within the beds of the then existing small rivers, which for the most part appear to be running now where they ran at the time of the mud-streams. Perhaps even these river sides have originally been covered rather continuously with red soil, but most of it has apparently afterwards been washed away by erosion, leaving only the highest patches untouched as red islands in a grey sea. In this erosion process of course also a considerable mixing of the two soil types has occurred.

It need scarcely be stated that by similar causes in the southern red soil-areas also some grey patches occur, and also here some mixing of the two soil types has taken place.

The grey soils are very different from the red ones. For two typical cases the silica and sesquioxide contents are presented in Table I.

TABLE I

	SiO_2	Al_2O_3	Fe_2O_3	Molecular Ratio $SiO_2/Al_2O_3+Fe_2O_3$
	Per cent	*Per cent*	*Per cent*	
Red soil..	36·7	26·6	15·3	1·7
Grey soil	57·4	16·7	7·1	4·6

From a pure pedological point of view one would assign a lateritic nature to the red soil, whereas the grey soil would suggest podsolic properties, thus giving rise to the assumption that these soils should have developed under quite divergent climatic conditions. Still the climate for the two soils is nearly identical with a yearly average rainfall varying between about 1,500 and 2,000 mm., distributed very unevenly between a wet monsoon from December to March, a dry monsoon

from May to October and the remaining transitional periods; and with temperatures varying between about 20° and 36°. The difference between the two soil types thus must be ascribed to the differential composition of the material from which these soils were formed.

The texture of the grey soil type is that of a clay-loam with only a small percentage of sand (particles of 2 to 0.25 mm. diameter), with some 25 per cent in the clay fraction (particles with smaller diameter than 0.002 mm.) and some 70 per cent in the middle fraction of particle size (0.25 to 0.002 mm. diameter). The texture of the red soil type is more that of a loam-clay with some 10 per cent more in the clay fraction and some 10 per cent less in the middle fraction of particle size. If, however, on this basis one would assign a better physical nature to the grey than to the red soil, one would make a big mistake. Whereas the grey soil is very sticky when wet, cracks when dry and disperses very easily in rain-water, the red soil is less sticky when wet, does not crack when dry and does not disperse in rain-water. Thus the red soil, although of a finer texture than the grey, has a better structure. Apparently the colloidal constitution, which is not revealed by texture figures, is quite different in the two soil types.

Although one might expect a higher capacity to absorb bases in the red than in the grey soil, this expectation is not realized. This capacity is on the average about equal for both soils, viz. about 25 mgr. equivalents per 100 $cm.^3$ of soil. On a weight basis, however, a difference exists in this quality, as the specific weight of the red soil is some 10 per cent higher than that of the grey. The range of variation in this capacity is much wider for the grey than for the red soil, ranging in the former from about ten to about forty of said units, and in the red soil from about twenty to about thirty. Also the range of variation in pH of the two soils under natural forest conditions is wider for the grey than for the red soil, for the latter about six to seven and for the former about four to six. The organic matter contents of the two soils are about equal, viz. about 3.5 to 4.5 per cent on a volume basis. The nitrogen contents of the organic matter are for both soils about equal, the carbon/nitrogen ratios under fresh forest conditions fluctuating around ten.

Besides the apparent difference in colloidal constitution, which may be associated with the difference in silica/sesquioxide ratio, there is a fundamental difference in microbiotic behaviour between these two soil types. Whereas the natural nitrogen supply may last in the red soil for tens of years of cropping without the necessity of nitrogenous manure, it is greatly exhausted in the grey soil by a few years of cropping. although as has been stated already, in the two soils the organic matter contents and so the nitrogen contents are very similar.

As may be expected under Java conditions, the material of young-volcanic origin, as found in the red soil, has supplied it with a much larger mineral plant food reserve than that with which the material of sedimentary, tertiary to quarternary, nature has supplied the gray soil.

From the differences described it will be understood that not only is the original fertility of the freshly cleared red soil much higher than that of the corresponding grey soil, but also that the exhaustion by cropping must take a much faster course in the grey than in the red soil. This exhaustion will be explained here not only for both soils, although sisal

waste has been used as manure at Soekamandi only in the grey. The author thinks this to be useful, because part of the waste used as manure in the grey soil originates from the red soil fields, while also the comparison of the two soil types as regards exhaustion should facilitate the understanding of the grey soil behaviour better than consideration of the grey soil alone.

However, before proceeding to this exhaustion history, still another apparent difference between the two soil types has to be considered, which, although of an incidental nature, is important from a practical point of view. The grey soil, when cleared from forest, appears to be covered with termite hills, whereas the typical red soil is free from them. This has apparently something to do with the sticky nature of the grey soil, which character seems to be favoured by the termites, as contrasted with the more crumbly nature of the red soil. Owing to these termite hills the natural grey soil has a very uneven surface.

The ant hill soil is a local soil surplus corresponding with a soil shortage between the ant hills, both due to the activity of the insects. Furthermore during the rainy season soil is continually being washed down from the ant hills and being spread around them. The result of these activities is that about in the centre between the ant hills low patches have been formed without natural drainage, surrounded by flat, intermediate land of a little higher level with the ant hills in their midst.

At an early stage of his investigations the author found that under natural conditions these ant hills in the flat grey land act as a sort of chimney during the wet monsoon. Water continually evaporates from them on account of their high and dry position, whereas large parts of the land between the ant hills are soaked or even covered with water during a considerable part of this season. The result has been a concentration of easily moving bases in the soil of the ant hills, especially of their internal, lower portions. Simultaneously the land between the ant hills has been robbed of these bases. Table II shows these facts clearly in the analytical data for saturation with bases, pH, exchange acidity, hydrolytic acidity and for the lime and magnesia contents. The base, potassium, and phosphorus, both of which are difficult moving substances, suggest a reverse effect. This may, however, be only an apparent one, caused by the exhaustion of these substances by the growth within the ant hills of the fungi, providing food for the young white ants, which, when full grown every year fly out from the hills and thus should impoverish the ant hill soil in potassium and phosphorus. Apparently this impoverishment goes on faster than the enrichment of the ant hill soil with these slowly moving substances by the flow of water from below. With carbon and nitrogen, which originate from the atmosphere and not from the soil, things are different again. Table II shows the carbon and total nitrogen contents to be appreciably better for the ant hill soil than for the low patches. This is probably due to the combined effect of the biotic interaction between the white ants and their fungi on the one hand; and of the better conditions for plant growth—on account of better drainage—on the ant hills as compared with the low patches. Pot culture experiments showed that also the *available* nitrogen conditions are much better in the fresh ant hill soil than in the fresh low patches soil. This results in a much better crop development on the ant hills than in the low patches, even when the difference in natural drainage has been

TABLE II

SOME ANALYTICAL DATA (1) OF THREE ADJACENT GREY SOILS (2), SHOWING INFLUENCES OF WHITE ANT HILL FORMATION

SOIL CHARACTERS	Sort of Soil	DEPTH OF SOIL LAYERS IN CM.					
		0 to 10	10 to 20	20 to 30	30 to 50	50 to 75	75 to 100
Capacity to absorb bases (3)	Ant hill ..	17·9	17·7	20·8	21·0	36·7	30·8
	Low patch	15·0	17·3	19·4	21·9	22·7	26·2
	Intermediate	16·9	17·8	15·7	17·1	32·1	21·5
Saturation with bases (4)	Ant hill ..	66%	64%	68%	74%	89%	94%
	Low patch	60%	56%	59%	51%	62%	69%
	Intermediate	47%	40%	49%	51%	68%	82%
pH (5)	Ant hill ..	4·07	4·14	4·05	4·32	5·06	6·33
	Low patch	4·40	4·28	4·32	4·43	4·33	4·25
	Intermediate	4·05	4·02	4·05	4·12	4·34	4·70
Exchange acidity ..	Ant hill ..	26·7	25·4	34·3	11·5	1·0	0·2
	Low patch	34·0	44·5	55·7	70·9	73·2	55·7
	Intermediate	45·3	56·6	59·1	64·8	57·5	12·6
Hydrolytic acidity ..	Ant hill ..	46·2	41·8	52·1	20·2	20·3	8·6
	Low patch	56·7	61·6	63·9	75·9	74·7	62·2
	Intermediate	70·8	72·6	68·6	71·2	78·6	30·6
Absorbed CaO (6) ..	Ant hill ..	1,330	1,450	1,670	2,050	3,570	5,040
	Low patch	820	850	990	900	1,110	2,090
	Intermediate	670	450	590	660	1,090	2,590
Absorbed MgO (6) ..	Ant hill ..	730	750	940	910	1,250	1,430
	Low patch	250	260	390	470	680	810
	Intermediate	440	330	330	300	640	1,370
Absorbed K_2O (6) ..	Ant hill ..	320	400	410	330	550	320
	Low patch	970	920	970	1,320	1,750	830
	Intermediate	290	330	870	510	50	450
Total P_2O_5 (6) ..	Ant hill ..	890	710	610	600	490	380
	Low patch	900	830	730	620	450	410
	Intermediate	1,430	870	670	660	510	420
Carbon (6)	Ant hill ..	21,100	17,400	15,700	15,600	13,400	9,400
	Low patch	20,600	18,700	12,100	9,300	7,600	6,600
	Intermediate	26,700	19,600	15,700	13,300	11,200	10,000
Total N (6)	Ant hill ..	1,720	1,690	1,550	1,500	1,530	1,440
	Low patch	1,650	1,270	1,410	1,080	890	770
	Intermediate	1,790	1,830	1,410	1,470	1,270	1,130

(1) Analyses after Vageler's methods (*cf.* remark to Table III of Part I).

(2) These samples were taken about 5 years after the clearing of the forest and planting of the sisal. It should therefore be taken into consideration that the top soils, especially that highest situated, have already undergone a considerable impoverishment, especially as regards lime and magnesia, on account of being washed out by rains.

(3) In mgr. equivalents per 100 $cm.^3$ of soil. The capacity to absorb bases is below average for these three soils, the average for grey top soil being about 25.

(4) In fresh ant hill top-soil about 75%. The fall to 66% has chiefly been caused by lime and magnesia being washed out.

(5) In the fresh ant hill top-soil about 6·5. The clean-weeded ant hills have suffered from the washing out of bases by rains and thus the pH has fallen in this soil relatively much during the 5 years of cropping, although it should be stated that in the present instance the pH is somewhat lower than usual after 5 years of cropping.

(6) In kg. per ha. per layer of 10 cm. thick.

equalized in clearing the land. Fig. 1 shows clearly the differential development of sisal on the ant hills as compared with that in the low patches.

From this description it is seen that in the grey soil the occurrence of the ant hills has led to a considerable dislocation of mineral plant food and to an important highly localized differential development of nitrogen conditions.The author showed by pot culture experiments with maize that a small admixture of ant hill soil with low patches soil caused a disproportionally large increase in crop production of the latter. Thus it was decided to level out the whole of the grey Soekamandi land by levelling the ant hills, filling up the low patches and simultaneously mixing the whole of the soil thoroughly. Although at first sight such a procedure might seem artificial, in fact it was a restoration of the primary surface conditions which had been disturbed by the soil transportation of the white ants. The levelling, as the procedure was called, not only restored the original land surface but also balanced out again to a large extent the differences in plant food which had resulted from the white ant activities.

The agricultural result of levelling was a considerable increase in soil productivity. While the fibre production on fresh non-levelled land under reasonable conditions of drainage and weeding may be estimated at 15 tons per ha. per cycle of 8½ years, production on fresh levelled land under otherwise equal conditions can be estimated at 17 tons per ha. per cycle of 7½ years, which figures equal 1.76 tons as against 2.27 tons per ha. per average cycle year.

It should be inserted here that all the production figures in this article apply to a system of planting about 6,000 plants per ha., arranged in double rows, and to a system of cutting twice a year, with the first cut about 1 to 1½ years after planting. These restrictions are quite essential for the production data quoted.

The most obvious result of levelling was the disappearance of the uneven sisal growth as shown by Fig. 1 for non-levelled land, Fig. 2 showing by contrast the regular sisal growth on levelled land. The levelling of Soekamandi proper was begun in 1926 and the whole of the 14,000 acres was finished by 1933.

This levelling business has been dealt with rather extensively for various reasons, e.g. because flattening of the land would have been necessary anyway to enable the land to be inundated with sisal waste, whereas it has been shown that levelling was a procedure that functioned as an economic measure by itself.

The following discussion of the exhaustion history of the grey and red soils will be chiefly on the basis of clean weeding the land and it might be questioned whether a different type of cultivation, e.g. interplanting the sisal with a green-manure cover, would not have prevented or at least appreciably retarded the exhaustion. The author studied, and still studies, the question of green-manure cover between sisal in the Soekamandi soils very intensively and has found that such a cover retards fibre production in fertile soils over the whole range of the sisal cycle. In unmanured fresh grey soil, which soon after planting shows nitrogen deficiency, the retarding effect of a green cover, brought in together with the sisal, lasts during the first four years after planting. Only after this period such covered soil begins to show an advantage over the uncovered soil, which advantage is however not able to enlarge the fibre production per average cycle year, on account of the losses incurred by the retarding effect during the first half of the cycle. In unmanured grey soil, as

FIG. 1.—Uneven growth of nearly six years old sisal in non-"levelled" grey soil. Note the sisal on the ant hill to be much larger than the coolie and in the low patch to be much smaller.

FIG. 2.—Even growth of 1½ year old sisal after 1st cut in "levelled" and well drained grey soil. The narrow distance between the rows is 3 and the wide distance 9 English feet.

already exhausted by one full sisal cycle, the total cycle effect of a green manure cover on the new sisal cycle is probably a positive one per average cycle year. However, in such soil the sisal production, even with the cover, is too low to warrant this soil being planted with sisal at all, without the aid of manuring with waste or chemicals. In every case it was found, however, that a green manure cover, either as a pure cultivation or interplanted between sisal, improved the soil fertility for a new crop, following the pure cover or the interplanted sisal, if the cover was either first worked under or its tops eliminated. It was, however, also found that under all but the very worst price for sisal fibre, treatment of the land with sisal waste and with chemicals was a more economic fertility-improvement measure. The foregoing remarks should not be understood as an absolute denial of the possibility of using a green manure cover between sisal economically in some way in the grey Soekamandi soil. The solution of the problem has however not yet been found with certainty. Anyway the outcome of the green manure studies has been that up till the present at Soekamandi estate a green manure cover is only planted between the sisal, where otherwise soil wash would do damage on account of the slope of the land. This is, however, only the case in the undulating "outside areas", where the cover is kept in as narrow strips as possible between the double sisal rows. As aqueous manuring is applied at Soekamandi proper only, it is thus not interfered with by green manure cover, and therefore the soil exhaustion history has to be dealt with for non-covered conditions only.

If a non-levelled fresh or nearly fresh grey soil is planted with sisal, drainage is reasonable, the clean weeding system is followed, and other treatments are as already indicated, the "fibre" production is rather small during the second year after planting, increases considerably during the third year, reaches its maximum in the fourth but shows a sharp fall in the fifth year. Thereafter it remains more or less constant until many plants begin to pole, whereby the production is raised at first, but afterwards when, on account of poling, relatively few plants are left in the field, the production drops again.

In a levelled field under otherwise equal conditions the production course is very similar in the second half of the cycle, but different during the first four years. In the second year the production is already considerable, and reaches its maximum during its third year; the sharp fall comes already in the fourth year, i.e. a year earlier than in the non-levelled soil.

In a fresh, or nearly fresh red soil, the production course is quite different again. The production in the second year after planting is about equal to that in the levelled grey soil, but from then on it rises almost continuously until a large number of plants have poled towards the end of the cycle.

TABLE III

PRODUCTION IN TONS PER HA. PER YEAR FOR THREE SORTS OF TYPICAL "SOEKAMANDI" AREAS, EACH OF ABOUT 600 HA. DURING THE FIRST FIVE YEARS OF THE SISAL CYCLE

SORTS OF SOIL	YEARS AFTER PLANTING			
	2nd	3rd	4th	5th
Non-"levelled" grey	0·36	1·83	2·98	2·12
"Levelled" grey	1·68	2·90	2·11	2·40
Red	1·83	3·35	4·45	4·06

Table III brings out these facts for large areas, which are typical in respect

to these facts, but which do not exactly represent average production data for Soekamandi estate. Table III shows for the non-levelled grey soil a production fall from the fourth to the fifth year, amounting to 29 per cent of the fourth year's production. For the levelled grey soil this fall comes already in the fourth year and amounts to 27 per cent of the third year's production. The difference between the fifth and fourth years' productions for the red soil, amounting to only 9 per cent of the fourth year's production, is incidental, caused by weather.

As already indicated, the data of Table III do not show exactly the average potential productivities. These, for soils planted freshly after forest clean-weeded throughout, with 6,000 plants per ha. arranged in double rows, cut twice a year, with the first cut about eighteen months after planting, can only be estimated, as in practice it is not possible to keep to all these conditions over all the areas, especially as at Soekamandi sisal is rotated with tapioca. The estimates are given in Table IV.

TABLE IV

Sort of Soil	Practice number of cycle years	Tons of "fibre" per cycle	Tons of "fibre" per cycle year
Non-"levelled" grey	8½	15	1·76
"Levelled" grey	7½	17	2·27
Red	6½	25	3·85

It is seen that the red soil is more than twice as fertile as the grey soil under natural non-levelled conditions, during the first sisal cycle. It is thus only to be expected that in the red soil the fertility lasts longer than in the grey. This can be illustrated only by estimates, such as those in Table V, derived chiefly from field experiments laid down under various conditions of soil exhaustion.

TABLE V

	Number of cycle years in practice	Tons of "fibre" per cycle	Tons of "fibre" per cycle year
"Levelled" Grey Soil—			
1st cycle on fresh soil	7½	17	2·27
2nd cycle ..	11	8·5	0·77
Red Soil—			
1st cycle on fresh soil	6½	25	3·85
2nd cycle ..	7½	18	2·40
3rd cycle ..	8½	12·5	1·47

A third cycle in the grey soil or a fourth in the red, without some form of manuring, would not produce any commercial leaf on account of physiological leaf diseases and insect pests.

Note by W. E. Calton, *B.A., Dip.Agric., East African Agricultural Research Station, Amani.*

This note is to explain what may be considered technical soil terms and to indicate as far as one can the degree of similarity between East Indian and East African conditions. From the text it can be seen that the grey soil is a stiffish soil, in flat and probably only moderately well-draining country, derived from coastal sedimentary rocks. It is very sticky when wet, cracks when dry and disperses very easily in rain-water in a way that is not uncommon in some of the East African soils. If, as may be likely, the manuring of this soil is more a question of improvement of physical condition and with it betterment of air and moisture supplies, of biological activity, including nitrate production,

and generally of the soil's capacity for utilizing existing nutrients rather than the addition of nutrients to an already favourable medium, then much of what Dr. den Doop has to say will be applicable to the stiffer greyish soils of East Africa. However, the silica sesquioxide ratio of this soil is unusually high judged by East African standards. Here such a ratio is found only in soils derived from old lake-bed deposits, and furthermore lime is usually present, inducing a granular rather than a greasy structure and preventing such a high degree of acidity (pH about 4) as has developed in the Java soil. The value of spreading lime-enriched termite heaps referred to in the paper is obviously partly due to its corrective effect on acidity. Lime-enriched termite heaps occur in parts of this country and may provide the equivalent of heavy dressings of lime in regions of acid soils, but their value often goes unnoticed.

The red soil is a more familiar type. Judging by its silica sesquioxide ratio and the friable nature of its clay substance it coincides with the red earth group of the East African Soil Map. It is not so impoverished, however, as the advanced laterized red earths on gneisses and granites that occur for example in Usambara, Uluguru, and on the Iringa Plateau. It also appears more fertile than the red earths proper on sandy formations. Its reaction (pH 6 to 7) is slightly acid to neutral, roughly the same as the East African red earths, although its exchangeable bases are moderately high. These have not had time to weather out from the young volcanic parent material even under the relatively high rainfall of Soekamandi. Exchangeable bases are important as plant foods and also as having a stabilizing effect on soil. They act as a buffer to the development of acidity, the breakdown of clay substance and the loss of structure. The Java red soil has bases of the order of 25 milligram equivalents per 100 grams, whereas comparative figures for East African soils are 30–40 for the fertile Kilimanjaro and similar volcanic soils and 5–10 for the ordinary redder soils on basement complex rocks. On this showing the Java red soils are better than the average East African sisal soil, though it is possible that some East African soils may not deteriorate at the rate indicated in Table V. Dr. den Doop's account of the treatment of this soil should therefore be of considerable interest to local agriculturists.

Farm Buildings in the Tropics

By R. J. MITCHELL, *Collegnes, Kitale, Kenya*

Assuming that the farmer has already established himself in a more or less permanent house, his next consideration will be the erection of suitable farm buildings. Their site will, to some extent, be governed by the position of the dwelling. Personal attention to the farm activities will be greatly facilitated by an orderly grouping of the farm buildings at a convenient distance from the dwelling. To preserve the pleasant appearance of the homestead, which it will be presumed has been aimed at from the start, complementary buildings, such as shop, garage, dairy, laundry, should as far as practicable conform to the architectural design chosen for the dwelling. Grass roofs should be avoided on the score of expense alone, apart from numerous other disadvantages. Provided the farmer has planned and supervised the building of his dwelling he will have gained much useful knowledge as regards quantities and estimates, as well as a clear grasp of the essentials that make for efficiency and permanency. The former means a maximum of service with a minimum of effort and the latter the elimination of the recurrent expenditure involved in all mud, wattle and grass buildings.

The choice of materials for the more permanent type of farm building will depend largely on the local supply. Stone suitable for building is a great asset on a farm, especially where there is no soil to be had suitable for brick-making. Where good bricks can be made, advantage should be taken of this kind of building material, as the cost will be considerably less than with stone. Burnt bricks are preferable to sun-dried bricks, which increase the cost of the building considerably and are less permanent and pleasing in appearance. While many farmers are conversant with the making and burning of brick on the farm, few realize the importance of the dimensions of the mould. For hand-made bricks the following will be found most economical: length, 9 in.; breadth, $4\frac{3}{8}$ in.; thickness, 4 in. Care should be taken to prevent the moulds wearing down, thereby reducing the thickness of the brick. If this is reduced from 4 in. to 3 in. the cost of the brickwork resulting will have risen by approximately 30 per cent.

Farm buildings being usually complementary to each other, their lay-out should be carefully planned. Ground sloping just enough to run rain-water off freely should be chosen. Foundations rarely require to be more than 1 ft. deep from surface level. If buildings are aligned at right-angles to the prevailing winds it will enable door and other openings to be arranged along the sheltered side. When digging foundations it is always well to bear in mind that the width of the building should bear a definite relationship to the length in feet of the iron sheets it is proposed to use for roofing. For example, a "span" roof of suitable pitch to accommodate 10-ft. iron sheets will adequately cover a wall span of 17 ft. out to out. If the outside width had been fixed haphazard at 16 ft. the cost of the building would have remained the same as in the previous instance with a greatly diminished interior space. The length of the building should also bear a definite relationship to the number of sheets of iron used. When making these calculations the eave overlap must be taken into consideration as well as the amount of overlap used in joining the sheets. The amateur builder

will here note that iron sheets should be placed with edges turning down only when covering up-turning edges of adjoining sheets. The result of this will be one over two and conversely one under two in consecutive order. If the iron be new the first corrugation overlap will give adequate protection for most if not all farm buildings.

The dimensions of the building being settled, work on the foundations may proceed. The laying of three rows of brick will approximate to surface level, where a cement damp-course should be applied. Four of sand to one of cement may be used and put down to a thickness of $\frac{3}{8}$ in. At this stage both side walls should be on a level, though the building may have a gradual slope from end to end. This is very often necessary, as in cow houses, for drainage.

The walls, which will be presumed to have a thickness of 14 in. (a brick-and-a-half), can now be carried up to the desired height. Two methods of bricklaying are usually employed, the English and the Flemish. The former is the commoner and consists of a row of headers and a row of stretches alternating. With the latter method the header and stretcher alternates in the row similarly on both sides of the wall. This latter method has an advantage over the former in that a half or broken brick can be used to fill the space that inevitably occurs in the centre of the wall with every fourth brick laid in position. In this way the broken or waste bricks can be used up without showing in the finished work. This method has also the advantage of reducing the seams exposed on the surface and thereby reducing the cost of cement pointing where this is resorted to.

Door frames should be built in and thoroughly secured to the brick-work at about half their height from the ground. A good plan is to drill a hole to take a $\frac{3}{4}$ in. bolt about 9 in. long and provided with a nut. When the building is at the necessary height the bolt is passed through the frame, the nut replaced and the whole grouted in with concrete and brought to the same level as the brick course it replaces. A concrete threshold should also be provided for, so as to secure the frame at the bottom. All frames should be treated with a wood preservative before being placed in position. When cow houses are provided with doors care should be taken to place the frames flush with the side of the wall against which the door will open. This will enable the door to go right back against the wall and so avoid damage by cattle squeezing out and in.

The foundations of brick walls should be cement plastered on the outside from 6 in. below the damp course to 9 in. above it. This will prevent the splash from roof-water coming in contact with the brick, which would otherwise absorb moisture and keep the base of the walls damp during the wet season.

A saving in roofing may be effected by using suitable sized gum trees for rafters and wall plates. If the rafters are placed at intervals of 4 ft., 3 in. × 2 in. sawn timber will give adequate support for the iron. Care should be taken to bed the sawn timber thoroughly on the rafters so as to get the necessary "level" and avoid any unsightly inequalities showing in the iron when the roof is completed.

A very important fact, and one that should always be kept in mind when building is contemplated, is that the most economical house is the one that suits the requirements and is well constructed. For the farmer the most expensive and least efficient building is undoubtedly the mud and wattle structure, which, though it may give temporary service, claims frequent attention for repairs and renewals and can never be considered an asset.

Quality in Egg Yolks

By M. H. FRENCH, *M.A., Ph.D., Veterinary Department, Tanganyika Territory*

Quality in an egg is judged partly by the quality of its yolk. The consuming public demand a large, well-flavoured egg possessing a highly-coloured yolk, and it is intended to outline some of the factors influencing the colour and quality of egg yolks.

From the point of view of the housewife an egg yolk consists of the globular mass of palatable and very nutritious fluid in the centre of an egg. This fluid is contained in a transparent membrane which separates it from the other parts of an egg, and which is responsible for maintaining its shape when an egg is opened and poured on to a saucer. Most people prefer that their breakfast egg shall have some definite yolk colour, but what that colour shall be varies with the person concerned. Egg yolks vary considerably in colour from very pale yellow, through a rich golden yellow, to a deep orange colour, and the colour preferred in one district may be discriminated against in an adjacent market.

Yolk colour was at one time thought to be a breed characteristic. It is now clearly recognized that this is not so, nor is yolk colour peculiar to any particular hen. Yolk colour is determined almost entirely by the feeding, and any given hen can be made to produce differently coloured yolks merely by alterations in her diet. The colouring matter in egg yolk is derived from certain pigments (chiefly the carotinoids and chlorophyll) consumed in the foods. The carotinoids, carotene and xanthophyll, produce deep yellow yolks whilst chlorophyll gives rise to darker orange-red yolks.

Many people in East Africa must have noticed the change from the rich orange yolks of the wet season eggs to the pale, and often very pale, yellow yolks of eggs at the end of the long dry season. This change is most apparent where the hens have to search for their own food and least obvious where green foods are supplied all through the dry season.

As an illustration of the effect of green food on yolk colour the following case is recorded. Four Rhode Island Red hens that had been living in ordinary grass pens since the end of the rainy season, were put under battery conditions in October. They were given a ration composed of white millet, groundnut cake and cowpeas. Two hens were given a handful of mulberry leaves daily but the other two received no green food at all. Two months later the eggs from the first pair had normal yellow yolks but the yolks from the second pair were practically devoid of pigments and it was not easy to distinguish by colour between the yolks and the white. This second pair of hens was then given green grass daily and the eggs seven days later were boiled and found to possess yolks which were white in the centre but yellow outside. Three weeks after starting grass feeding the yolks were found to be completely yellow. Egg yolks do not increase from their centres but by the deposition of concentric layers of yolk material on the outside of that already formed. The white centred yolks mentioned above had begun their growth on the poorly pigmented ration and then, when pigment rich grass was supplied, had deposited coloured layers on the surface of the immature almost colourless yolks.

Since the consuming public, rightly or wrongly, demands an egg with a well-defined coloured yolk, the poultry farmer

must supply this demand or lay himself open to criticisms or even loss of customers. Also, because of the absence of green grass in the latter half of the dry season, the East African producer must grow and feed those foodstuffs which will maintain the colour of the egg yolks. This can be achieved by feeding yellow maize (in an amount about equal to half the total ration) and green foods grown under irrigation, such as grass, lucerne, lettuce, spinach, cabbage, etc., or the young green leaves of local shrubs and bushes.

Certain foodstuffs give rise to different yolk colours: yellow maize and green foods produce deep yellow yolks; oats, rice, wheat, barley and their by-products, with milk, meat and fish meal, give rise (according to Halnan) to pale yellow or nearly white yolks. Young green foods rich in chlorophyll tend to give dark orange-red yolks; cabbage a brighter orange-red, and beetroot a dark yellow. Linseed on the other hand gives yolks a greenish tinge.

By giving the correct supplement to the poultry ration yolk colour can therefore be maintained through the height of the dry season. There is, however, probably no correlation between the colour of the yolk and its nutritive value, except that the Vitamin A activity of the yolk will increase with increased carotene deposition. In view of this the East African consumer should be more tolerant of the pale yolks in the dry season, but it does not excuse the producer from failure to maintain the normal yolk colour.

There is one other factor which also appears to affect the colour of egg yolks. I have noticed in the dry season that the yolks of eggs from birds who have nearly completed a laying year (of 200 eggs) are paler than those from pullets who have only recently commenced to lay, even though their food and management are the same. The strain of a long heavy laying period appears to affect the power to deposit pigments in the yolk. One occasionally hears the complaint in the dry season that eggs from native hens possess better coloured yolks than the eggs from a good flock of British birds. This is because the native hen lays but a fraction of the total eggs laid by a hen of a good European strain and also lays a much smaller egg. The pigments which are insufficient to colour adequately the many large yolks from the European breed are more than enough to colour the much fewer smaller yolks of the native hen.

There is one other factor by which yolk quality can be judged and that is by the ability of the yolk to retain its almost spherical shape and to withstand a certain amount of handling without breaking when the egg is opened. When a freshly laid egg is opened the membrane is strong and the yolk stands up well when poured on to a plate. In an egg that has been kept for some time the yolk membrane is much weaker and ruptures very easily, whilst the yolk does not stand up well but spreads out when the egg is poured on to a plate. This property is a measure of freshness, and the rapidity with which the yolk membrane loses its strength depends on storage conditions.

Storage at temperatures below 65° F. and storage in a humid atmosphere reduce this rate of loss of quality. High temperature, particularly in a dry atmosphere hastens this deterioration of quality. During storage the egg yolk absorbs water from the surrounding thick albumen and this intake of water stretches and consequently weakens the yolk membrane, so that, when the egg is opened,

the membrane is unable to maintain the normal yolk shape and is also liable to rupture easily.

Feeding does not have any influence on yolk deterioration due to intake of water during storage (as measured by the rate on increase of the yolk weight), but the extent of this change depends on the conditions of storage and also varies between the eggs from different hens. Egg producers should therefore store their eggs at as low a temperature as possible. A simply and cheaply constructed charcoal cooler makes quite an effective storage cupboard. Also eggs should not be allowed to lie about in the nest-boxes for longer than necessary, whilst care during transport to prevent undue heating by the sun will enable eggs to be delivered in a better condition.

Summary

(1) The quality of egg yolks depends on: (*a*) the colour, and (*b*) ability to retain shape and withstand handling when the egg is opened.

(2) Yolk colour is dependent entirely on the feeding. Pale yolks during the dry season can be corrected or prevented by suitable supplements.

(3) The ability of the yolk to retain its shape and withstand handling is not influenced by the feeding, but varies with individual birds and is governed by the storage conditions. Low temperatures and moist air reduce the rate of deterioration.

Notes on Various Indian Methods of Curing Tobacco

During a recent visit to India, I came across some methods of curing various types of tobacco that may be of interest to East African readers.

In Bengal, where the rainfall in tobacco areas varies from 55 in. to 100 in., some 307,600 acres of rain-grown tobacco were grown in 1934–35 and the production of leaf was 144,000 tons. The product is air cured and is mostly exported to Burma for the manufacture of Burma cheroots. The leaves are dried separately in the sun on the ground for three to five days until the midrib is dry. They are then tied into bundles of ten to fifteen leaves and stacked by the grower, supervised by the buyer's agent, in buildings roofed with either grass or galvanized iron. The stacks heat and lose water. After one week they are examined frequently and prevented from overheating by restacking as necessary. In three months' time the colour is the requisite shade of brown and the leaves are ready for baling. The average bale is one of 150 lb.

At the famous Experimental Station of the Madras Government at Coimbatore another type of tobacco was seen in connexion with the extension work of the station. This tobacco is a heavy type grown under irrigation and used for chewing. Yields of 1,500 lb. per acre of semi-dry leaf are obtained. In this case the plants are cut off at ground level and left to wither with the leaves adhering. After a day, they are gathered into loose heaps and left to wither in the field for two more days. They are then put into a silo pit previously lined with straw, covered with straw and lastly with mud and allowed to ferment for ten to twelve days. The pit is then opened and the leaves cut off, each with about 3 in. of the central stem adhering to prevent too rapid drying. The central stems are then threaded

into hands or bundles of about fifteen and tied with sisal twine. The hands are then hung up to dry for three days in the field on trellises. They are then dressed and stacked for additional fermentation. At first the stacks are turned daily and then less frequently, the governing factor being that they must never be allowed to overheat. The eventual product is dark brown. An alternative process omits the silage stage.

Brilliant sunshine and no rain are the rule at Coimbatore at the season for curing tobacco. On January 21st, on the occasion of my visit, some fields had been cut and others were nearing the ripening stage.

At the Poona Agricultural Experimental Station a third method of curing tobacco was noted. In this case, the strain used was a highly bred local one, known as Gandier No. 6, the leaf being used for the production of strong cigarettes, pipe and chewing tobacco. The whole plant is cut and dried in situ on the ground for about a week. Before dawn, when the leaves are damp with dew, they are placed, still adhering to the main stalk, in a silage pit lined with sorghum stalks. The pit is then covered with straw and finally with dry soil. After twenty-four to forty-eight hours, depending upon the colour that is required, the pit is opened. The leaves are cut from the stem and tied in flat bundles to weigh 3 to 4 lb. The bundles are placed in bulks in a store for about three weeks, being turned frequently according to the temperature. The bulks must not be allowed to overheat. This tobacco is grown under irrigation and there is no rain at the time of harvesting.

A bright Virginia type, known as "Harrison's Special", is grown under irrigation with abundant sunshine and no hail. The plants are not topped and are allowed to go to seed. After discarding the lower two leaves, the remainder are picked one at a time as they ripen, each plant in the course of the season producing twelve to fourteen leaves fit to cure. The ripe leaves, as picked, are taken to a model flue-curing barn with two fires, each flue being S-shaped. The routine for curing is 24 hours at 90° F., then 8–10 hours at 95° F., followed by 5 hours for each step of 5°F. up to 125°F., then 3–5 hours for each step of 5°F. up to 160°F., the process being completed when the midrib becomes dry. A few of the leaves seen had been dried too green, but the majority were an excellent bright yellow colour. J. D. T.

Food Crops and Food Shortage

A REVIEW OF WORK BEING DONE IN THE COASTAL DISTRICTS OF KENYA

By N. HUMPHREY, *Agricultural Officer, Department of Agriculture, Kenya*

INTRODUCTION

Broadly speaking, the rainfall belts of the Coastal region may be divided as follows:—

(*a*) The Coastal Strip, in which the long rains are more reliable than the short rains, with an average annual rainfall of over fifty inches in the south to about forty inches in the north.

(*b*) The Coastal Hills, along which the rainfall is somewhat heavier, but the seasons generally conform to those of the Coast.

(*c*) The back country, in which the rainfall is definitely lower than in the other belts. This area is marked by the tendency of the short rains to be more reliable than the long rains.

Distribution throughout is extremely erratic and results in frequent long dry spells, whilst the bulk of the season's fall may be concentrated into a short period of heavy and continuous rain. The effects of this faulty distribution are enhanced by the lightness of the average coast soil and by the strong monsoon winds, which greatly hasten drying-out in a period of sunny weather. Thus although the average annual rainfalls appear to indicate a reasonably satisfactory position, for the reasons mentioned above the coastal area is frequently subjected to food shortages, which sometimes constitute famine. A further adverse factor has been present, particularly in the areas most subject to bad seasons. This has been the abandonment of small cereals in favour of maize and the reliance on the latter crop for both food and cash.

Under such conditions progress is almost impossible and it has been the main object of this department to put native agriculture on a sounder footing. With a primitive people, suffering severely from debilitating diseases and scattered widely over a large area, the work has been difficult and slow. It has proceeded on two chief lines, the introduction of cash crops, such as cotton and cashew nuts, with the object of lessening the need for excessive sales of food crops; and the improvement of the actual food crop position. It is the latter subject with which this article is concerned.

THE PROBLEM

It has been noted above that maize had largely ousted the sorghums and millets from cultivation. This process might have been a gradual change that could have been checked, but the great famine of 1917 involved large-scale relief in the form of maize and it is reported that the change from that time was rapid. Natives have now become so used to maize as their staple food crop, that its elimination from cultivation, even if desirable, could not be contemplated.

The need for protecting other cereals from attacks by birds has increased their antipathy towards these crops, though in the past it was accepted as a part of the work of the farm.

If the problem is to be solved successfully, therefore, it would appear that, firstly, a suitable drought-resisting variety of maize should be found. Secondly, an effort should be made to re-introduce other cereals into cultivation, but the

varieties chosen must have in themselves some striking characteristic, that will give them favour with the growers. Thirdly, the cultivation of cassava should be increased and the most suitable types ascertained. It is on these lines that work has been carried out in recent years.

Maize

The most promising method of approach with this crop appeared to be the trial of quick-maturing varieties. In the majority of years of short rainfall, these might be expected to be able to ripen their crop without serious loss, whereas the average coast maize would be more or less a failure.

Accordingly a number of yellow flints were introduced. At a later stage the American white variety "Guam" was added and an Australian yellow dent, named "Durum". This latter variety quickly demonstrated that it was able to stand up well under dry conditions, even though its season was nearer that of the local maize than that of the quick-maturing types. "Guam" never lived up to its American reputation and the majority of the yellow flints were unattractive and apparently of no great value.

Finally, statistical trials of the most promising were carried out. The result was satisfactory, as it showed that "Durum" would give heavy yields under favourable conditions and produce the best results under dry conditions. The maize itself was of good quality and was more likely to be popular with natives than the small hard flint types. It was, in fact, a variety that could be issued in all parts of the Coast. Previously, the possibility of having to issue one variety for the dry areas and another for the rest of the Coast had been envisaged. The difficulties of carrying out such a scheme would have been extremely great, if they could have been surmounted at all, and it was gratifying to find a variety that could be issued with confidence in all areas.

In view of the fact that the original supply of "Durum" was extremely small, a request was made to Australia for a larger quantity. Bulking from this is now in progress and further selection work within this variety will be carried out.

Sorghums and Millets

The need for introducing alternative cereals to maize has already been stressed. However, the difficulties of getting natives to begin growing them extensively again were not fully appreciated at the time. Experience has shown that unless the new introduction has some special and obviously attractive characteristic the native will rather risk the loss of his crop than take a little trouble in scaring birds. Thus the sorghum "Ikumba", though it proved a most promising type, was not acceptable to native tastes and had to be abandoned. Similar difficulties have been experienced with other crops.

Sorghum varieties were introduced from America, South Africa, Tanganyika and the Nyanza Province of Kenya. To these were added some of the local types, still remaining in cultivation in certain areas. Elimination was based on yield, habit and flavour. Many of the introductions failed to adjust themselves to local conditions and after repeated trials were rejected; loose heads proved less suitable than compact ones; the majority of the Nyanza types were too bitter to the taste.

The American variety, Dwarf Hegari, showed up well at an early stage. It is a small plant with a compact head and white grain of good quality. By close planting yields of five-and-a-half to six

bags per acre were obtained. Its most attractive feature, however, was its short season, the crop ripening in from three to three-and-a-half months. This early habit is a character easily appreciated by the native and the variety has obtained considerable popularity. Its bulking and issue, it is hoped, are breaking down existing prejudices against small-grained cereals. Hitherto this variety has not been attacked by stalk-borer. This pest seriously reduces maize yields and in the Lamu District is reported repeatedly to devastate the sorghum crop, which is still of considerable importance there. So far, though Dwarf Hegari has been grown adjacent to heavily infested maize, no damage has been noticed. The importance of this will be realized and observations are being continued to obtain confirmation.

The variety "Bonganhilo" from Tanganyika is a longer-season sorghum of good quality. It is, however, not being issued at present, sufficient seed being harvested to keep it going for possible increased use later.

Amongst the millets satisfactory results have been obtained with Awned Bulrush Millet from Tanganyika and the quick-maturing selection of *Eleusine* from Nyanza. Foxtail Millet has also been under trial. Some awned plants were observed in this crop and experience so far suggests that this awning definitely lessens depredations by birds. Selection for yield and awns is being carried out at the Experiment Station.

Cassava

Work on cassava was started by collecting all local varieties available and trying them against imported types. Particular attention has been paid to resistance to mosaic disease.

In the original trials it was found that "Binti Athman", a variety already in cultivation, whilst always heavily infected with mosaic, always produced fair yields. The variety "Shelli-Shelli", which came originally from the Seychelles, appeared to have considerable resistance but was definitely inferior in quality to "Binti Athman".

Later, the writer found a plant growing in a native plot, which appeared almost free from mosaic, although neighbouring plants were heavily stunted through the disease. Inquiries failed to show that this was a recognized variety and it was consequently named "Malindi" and included in the trials. This variety has shown itself to be consistently very highly resistant to mosaic. It has proved to yield more heavily than other varieties tried against it and it is ranked high from the point of view of palatability. Accordingly, it has been accepted as the standard variety and is being brought into cultivation as quickly as possible. Work is continuing at the Experiment Station with new introductions, chiefly from the East African Agricultural Research Station, at Amani, and with seedlings from Malindi. Should any of these show immunity or very high resistance to mosaic, they will be tested later statistically against "Malindi".

Legumes

Legumes are not a main factor in preventing food shortage, but it is clear that it is desirable to obtain suitable varieties for the particular conditions already outlined. Thus a cowpea variety "New Era" has proved to be a quick-maturing, heavy yielding type, and is now in demand amongst native growers. Tepary Beans have been introduced and efforts are being made to obtain a selection more tolerant to Coastal conditions than the original importation. The indications are that such a selection may be obtained before long. The Cluster Bean is at present under trial and promises to

be an introduction of considerable value. Further trial, however, is required before it can be considered to be proved.

Seed Issues

No discussion of improvement of food crops would be complete without some reference to the matter of seed issues. It is one thing to prove a crop suitable; it is another to introduce it into general cultivation amongst backward tribes.

In the case of maize, the chief difficulty is the elimination of other varieties. It is necessary to stress here that success under Coast conditions will only be achieved provided suitable cash crops are available to lessen excessive sales of maize, which have been such a prominent feature in the past. This is one of the main reasons why cotton growing has been, and is being, encouraged.

Whilst many of the areas affected are thinly populated with widely scattered plots, the Sabaki valley offers an area of comparatively easy control. This area will be used, therefore, as the basis for the large-scale maize issues contemplated in the near future. It should form a sound foundation for issues in the more scattered areas.

The same difficulty does not apply to the other crops. The general scheme for these depends on strict supervision of a particular crop in a limited area and subsequent more rapid extension as the variety becomes popular. This method has been successfully applied to Dwarf Hegari; the variety has been given a full chance to show its merits and has accordingly won great popularity. The same applies to New Era cowpeas. Not only is subsequent rapid extension of cultivation comparatively easy but the attitude of growers becomes so much more favourable that introductions of other crops may be expected to meet with much less difficulty than has been the case in the past.

In the case of cassava, issues are based on the establishment of plots in each location, which, together with the main bulking places, provide planting material for growers. Ultimately, every grower will be expected to maintain a quarter of an acre of mosaic-resistant cassava as a famine reserve and this should do much to improve the general food position of the reserves.

In conclusion, it may be noted that whereas the experimental work required is a matter for the Experiment Station, the practical applications of results on the lines set out in this section necessitate close co-operation between administration and the agricultural staff in the districts; and the writer would wish to acknowledge the great help that has been received from administrative officers in this joint effort to improve the welfare of the local tribes.

Tree-Planting on Farms

By S. H. WIMBUSH, *Research Officer, Forest Department, Kenya Colony*

It is now eight or nine years since the Forest Department obtained the co-operation of a number of farmers to establish experimental plots in areas remote from the Forest Reserves. Offers were accepted to prepare small plots of land on certain farms and to plant a variety of trees supplied by the Forest Department, with the object of getting some information as to what kinds of useful trees would grow in the different districts. Some of these plots were not properly looked after in their early years and had to be discarded, but several farmers took the trouble to keep out fires and cattle, and at the present time sufficiently definite results are available to make it worth while listing the most promising kinds of trees in each of the plots as a guide to others anxious to make tree plantations for fuel, windbreaks, etc., in similar localities.

The successful plots now remaining are at Ruiru, Ngobit, Njoro, Rongai, Londiani, and on the Lake plains. The sites are described in more detail below, with a list of the kinds of trees that appear so far to be growing best.

Ruiru.—On Manbré Estates between Ruiru and Kamiti, on flat grassland with black clay soil, rainfall (1931–1935) 29 inches per year, altitude 5,150 feet. Trees planted in 1931. The most promising kinds in 1938 were as follows:—

Eucalyptus paniculata, E. rostrata, E. siderophloia, E. sideroxylon, E. melliodora and *E. Maideni,* suitable for fuel, poles or windbreaks.

Cupressus arizonica and *C. torulosa* for windbreaks, softwood timber or clipped hedges.

Casuarina Cunninghamiana is also growing well and makes a good light shade or windbreak.

This plot is typical of the Ruiru–Thika black-soil grass plains.

Ngobit.—Eastern Aberdares on Capt. D. Sharp's farm above the Nyeri–Rumuruti road, 6,800 feet altitude, 27 inches per annum rainfall, black soil, on a grass ridge with a few thorn trees and very exposed to the high winds prevailing for a great part of the year. Planted 1931 and following years. The most successful trees so far have been:—

Eucalyptus paniculata (fairly fast) and *Euc. crebra* (rather slow) for windbreaks, poles and fuel.

Schinus molle (pepper tree) and *Croton megalocarpon* (the native *mukinduri*) for shade.

Aberia caffra (kei apple) and *Euphorbia tirucalli* for hedges and windbreaks.

This plot may be taken as giving an indication of what trees will grow in the exposed grassland country of the eastern lower slopes of the Aberdares and the Laikipia district between the Amboni and Pesi rivers. Other species should also grow here and they are now being tried in a further plot on the same farm. Owing to the drying winds it is absolutely necessary that all trees should be carefully tended during the early years.

Njoro.—At the Plant Breeding Station near Njoro railway sation in the Rift Valley, altitude 7,100 feet, rainfall 34 inches per year. Planted 1930. In 1937 the most promising trees were:—

Fuel: *Eucalyptus rostrata, E. paniculata, E. siderophloia* and *E. saligna.*

Poles and hardwood timber: *Eucalyptus paniculata, E. sideroxylon, E. citriodora* and *E. crebra* (slow-growing but very durable).

Windbreaks: *Eucalyptus paniculata, E. maculata, E. punctata, E. Trebuti,* and *E. saligna.*

For the frontage to a windbreak: *Cupressus torulosa, C. arizonica,* and *Callitris robusta.*

Softwood timber: *Cupressus torulosa.*

Hedges: *Aberia caffra* (kei apple), *Cupressus arizonica* and *C. torulosa.*

Shade trees: *Cupressus funebris, Brachychiton populneus* (bottle tree or Currajong), and *Croton megalocarpon* (the native *mukinduri*).

This plot is typical of the Njoro country around 7,000 feet altitude.

Rongai.—Planted in 1929 by Messrs. Evans Bros., Ltd., on their Olongai farm, in the Rongai district, north of Nakuru. Altitude 7,000 feet, rainfall about 30 to 35 inches per year. Soil, volcanic ash. The most promising kinds of trees are:—

Fuel: *Eucalyptus rostrata, E. siderophloia, E. maculata, E. citriodora.*

Poles: *Eucalyptus melliodora, E. citriodora, E. sideroxylon* and *E. crebra* (slow-growing).

Windbreaks: *Eucalyptus citriodora, E. maculata, E. siderophloia, E. melliodora, E. rostrata.*

For the frontage to a windbreak: *Callitris robusta, Casuarina leptoclada, Pinus halepensis, Cupressus funebris and Grevillea robusta.*

This plot is on land typical of the Rongai–Menengai–Nakuru country. Probably less favourable soil than the Njoro plot.

Londiani.—On Messrs. Evans Bros., Ltd.'s farm just outside the township on the Eldoret road. Planted in 1929 in typical heavy ill-drained land. Altitude 7,800 feet, rainfall 42 inches but subject to long dry spells The most promising kinds of trees are:—

Eucalyptus punctata, E. globulus, E. maculata, E. saligna, E. paniculata, E. melliodora and *E. robusta.*

In another experimental plot planted a few years later in swampy land with murram close to the surface, on Mr. Peto's farm at Londiani, so far the most promising trees are:—

Eucalyptus melliodora and *E. punctata.*

These plots are on land typical of the heavy non-forest soils of the Londiani district.

Muhoroni–Kibigori district.—Planted by Messrs. Evans Bros., Ltd., on land at Chemelil now owned by the Victoria Nyanza Sugar Co., Ltd. Altitude 4,000 feet, rainfall 45–50 inches. The most promising trees are:—

Fuel and Windbreaks: *Eucalyptus rostrata, E. maculata, E. paniculata, E. citriodora* and *E. sideroxylon.*

Poles: *E. resinifera, E. melliodora, E. crebra* and also the species listed above for fuel and windbreaks.

Windbreaks: Any of the gums listed above.

For the frontage to a windbreak: *Cupressus torulosa* and *Callitris robusta.*

This plot is typical of the black soil of the hot Kano plains country.

Other Plots.—An interesting tree-plot is one established by the Forest Department in the hot dry sandy country east of Machakos, on the Thwaki River at Kiteta, north-east of Mbooni Hill in the Machakos Native Reserve at about 4,000 feet. There are probably farms in country similar to this in the Donyo Sabuk and Kima districts. The best species at Kiteta are:—

Fuel and Poles: *Eucalyptus crebra, E. citriodora* and *Cassia siamea.*

Shade and Soil Cover: *Parkinsonia aculeata, Turraea abyssinica, Croton megalocarpon, Melia azedarach.*

In the last year or two other experimental plots, in the form of demonstration windbreaks, have been established at:—

Ulu (Major Joyce);

Nanyuki (Mr. Thompson);

Rongai (Mr. Wolryche-Whitmore);

Njoro (Plant Breeding Station); and

Molo (Mr. Pell-Smith).

The Forest Department is grateful to these gentlemen for providing the land

and agreeing to maintain the plots, which means weeding for a year or two and keeping out cattle and fires. Without attention such windbreaks are never likely to do much good and farmers must be prepared to fence and to spend a little annually on maintenance at any rate for the first few years. The benefit to crops or grazing, apart from the value of thinnings for fuel and poles, should more than compensate for this expenditure.

Leaflets containing suggestions for windbreaks and shade trees are obtainable from the Forest Office, Nairobi, but it is hoped to publish an article on these when results of present experiments are more visible.

Pneumatic-Tyred Farm Vehicles

The use of pneumatic-tyred roller-bearing wheels on farm vehicles is becoming increasingly common. Often parts of broken-up motor cars are used and occasionally the axle, bearings and wheels are retained, but with the pneumatic tyres replaced by iron bands bolted to the rims.

Some interest attaches to the results of tests carried out at the University of Reading farm. Loads of 17½ cwt. of basic slag in two-wheeled carts were carefully balanced and the tractive effect on movement registered by means of a dynamometer. The loaded carts were drawn over a grass field in wet winter condition and an unploughed field from which mangolds had been carted.

The dynamometer recordings over grass were 150 lb. with pneumatic tyres and roller bearings, 175 lb. with pneumatic tyres but without roller bearings and 275 lb. with ordinary wheels and iron tyres. Over soft ground the recordings were 350 lb., 350 lb., and 475 lb. respectively.

The effective horse-power required on grass at an assumed speed of 1½ miles per hour was calculated as 0.6 with pneumatic tyres and roller bearings, 0.7 with pneumatic tyres but no roller bearings, and 1.1 with ordinary iron-shod wheels. Over soft ground the figures were 1.4, 1.4 and 1.9 respectively.

The authors conclude that the power required to pull a pneumatic-tyred cart is only about two-thirds that required to pull an ordinary cart with iron-shod wheels, and further that the difference is accounted for by the tyres and not by the roller bearings. It would appear, then, that no advantage is realized if roller-bearing wheels are shod with iron tyres. The authors remark that "whereas the pneumatic tyres left very little impression on the soil and might be said to lie on the surface over a breadth of 6 in., the iron tyres sank in 1½ in. on the grass and left a very marked rut. This difference was more noticeable still on the fallow."

It is curious in view of this last observation that whereas the absolute excess of horse-power required with the iron-shod wheels was 0.5, both on grass and on fallow, the proportional excess was 83 per cent on grass as against 27 per cent on fallow. Possibly some of the effect on fallow was absorbed by the clinging of mud to the greater surface offered.

V. L.

The Sotik Co-operative Settlement Scheme

By K. DE P. BEATON, *Sotik, Kenya Colony*

Some time ago settlers in Sotik, as in most other districts, realized that to rely on one-crop farming exposed them to a grave risk. It was also obvious that many settlers had more land than they could use economically with the limited financial resources at their disposal. Instead of the district being fully developed large areas of land were lying idle, in fact deteriorating, for they were being ruined by the wasteful methods of cultivation employed by squatters.

The first problem was solved at once. The district was suitable for the production of many crops, while the grazing was probably some of the finest in the Colony. Within a year practically every farmer had turned to mixed farming. Many different crops were tried. Some proved a failure, others most successful. These experiments proved, however, that there were many profitable lines of farming at the choice of the settler; also that with fencing and dipping the pastoral areas, though endemic to East Coast fever, could be quickly and safely cleaned.

Closer settlement would solve the second problem. This was more difficult. To attract new settlers there must be some concrete scheme to put before them to show that mixed farming was a proposition well worth considering. More must be done than rely on the slogan: "Come and settle in Kenya". The scheme must be worked out in detail. There must be figures to show what the expenditure was likely to be; what returns could reasonably be expected; and above all to show that mixed farming could be started and carried through to success by the man with a limited capital.

Where closer settlement is to prove successful there must exist certain conditions. In many areas closer settlement would immediately be faced with problems such as a shortage of labour, grazing and water. In Sotik these problems do not arise. The district, comprising some 170,000 acres, is one of the most fertile and promising in Kenya. An all-weather road connecting the district with the railway at Lumbwa is at present being built, and will be completed by the end of the year. In Sotik one finds a gently undulating country, which is well watered and fertile. With an elevation of between 5,500 and 6,500 feet, the district enjoys a climate that is almost ideal. One of the features that sets the area apart from other districts is its even rainfall. Never here, as in other parts of Kenya, does the fear of drought haunt the farmer, for with an average rainfall of between 3 to 5 in. a month, it is unknown. Pasturage is always green and plentiful, and when properly managed is capable of carrying a beast to the acre. The district lends itself to mixed farming and dairying, which are now being extensively developed. The soil is a rich chocolate loam, with a deep red sub-soil, while interspersed with the arable areas are blocks of beautiful park-lands of what must be some of the finest grazing the Colony has to offer. For all farming operations labour is cheap and plentiful, as Sotik is bounded on all sides by native reserves.

With all these natural advantages, a group of Sotik settlers formed themselves into the Sotik Co-operative Society, Ltd. The object of the Society is to assist new settlers to start farming on a sound basis,

to save these men any unnecessary outlay of capital and to enable them, by means of easy payments, to purchase their land out of the profits of their farming.

The promoters of the scheme owned enough equipment, such as ploughs, harrows, oxen and machinery, to develop the whole district. For many months in the year a lot of this equipment was lying idle. Why not make all this available to new men, saving them a large outlay of capital? Further expense could be saved, and water conserved, by erecting central dips and dairies. Co-operative transport, and preliminary cleaning of the land from a stock point of view, would help.

There were many difficulties to starting operations on private land. The Society approached Government with an outline of the proposed scheme. After going carefully into all the details, Government proved to be most helpful and encouraging. It made available, under favourable terms, an area in the centre of the district, on which to give the scheme a trial. It gave the Society a lease of the land for a period long enough to see whether such a scheme would work, and whether it would prove to be an attractive proposition to prospective settlers.

To-day, the Sotik Co-operative Society possesses a fully equipped home farm, run on model lines by a resident manager. Surrounding the home farm are a number of 500-acre farms available for settlement under the terms of the scheme. The land is good, consisting of rich arable land and fine pastures. The area is being cleaned from a stock point of view, and dipping facilities are available.

The new settler is advised to go in for cattle, maize, and passion fruit, all of which are established on the home farm. Other profitable lines such as pyrethrum, tobacco of high nicotine-content, poultry, pigs and sheep, might well be tried.

The settlement scheme offers wide advantages to the new man which are not available to one who starts farming independently. The settler is saved the capital required for equipment. He has the use of all the Society's implements, while the central dairy obviates the necessity of acquiring his own. The Society provides dipping facilities and the use of its transport organization. The settler shares running costs and depreciation, which are naturally less than if he were the actual owner.

The usual practice for a new man, intending to settle in the country, is to pay pupilage to some established farmer for a year or so to learn farming. Under this scheme he starts on his own land with the help and guidance of the resident manager, and the advice of the Board of Directors, who are all men of long farming experience.

The new settler has to become a member of the Society, taking up not less than ten £1 shares at par. He may lease a farm from the Society for a period of five years with the option of purchase. The rent for a lease is at the rate of Sh. 1 per acre; of this sum the Society credits the settler with shares in the Society to the extent of 95 cents in each Sh. 1 paid. In the event of the option to purchase being exercised the price of the land is £1 per acre, payable in ten equal annual instalments. From the date of exercising the option he also has to pay a rent of 20 cents per acre directly to Government, under the terms of the Crown Lands Ordinance. The purchase price includes all transfer and survey fees.

The Society, on its part, agrees to conserve an adequate supply of water on the farm; to connect the farm by road to the main road system; to make available, free of charge, rough timber for fencing and the necessary farm buildings; to help in the recruiting of labour; to plough at cost; and to dispose of all dairy produce through the central dairy run on co-operative lines.

In the event of his not exercising the option to purchase within the required period, the settler would be entitled to compensation for developments made by him during the term of his tenancy. The amount of compensation is, like all other disputes, to be decided by arbitration.

It is hoped when this land has been settled, to extend the scheme to the surrounding private land. As the area widens other centres for dips and dairies would be established as required. It is intended to buy good bulls, and with the promised help of the Veterinary Department, to employ artificial insemination. A passion-fruit factory is already working in the district, and crops are exceeding all expectations on established plantations.

The Society is printing a brochure in which will be found the terms of agreement, estimated costs and running expenses over a four-years' period, with a balance sheet at the end of the fourth year. It is estimated that a man taking up one of these farms should have a capital of from £1,200 to £1,500. The figures show that after the second year a good profit should be made.

There is also available an illustrated brochure on Sotik, issued by the Sotik Settlers' Association, describing the district in detail. It contains a map, gives living and building costs, social and sporting amenities and much other useful information.

It is hoped that provided both the Society and its members work together in a true spirit of co-operation a great future lies before it, and that it will be the means of making Sotik into a sound and prosperous farming community.

Serere Experiment Station

Historical and General

Serere is situated in the south-west peninsula of Teso District. The natural vegetation of the area is *mutala* scrub, and the soil an easily eroded sandy loam. The station was first opened in 1919–20 as a successor to the original station at Kadunguru in the same peninsula. The original purpose of the station was to provide land for the increase of improved cotton varieties grown under supervision. In those days the station was under the control of the Senior District Agricultural Officer who, in addition, had charge of Teso and Lango Districts; he was also mainly responsible for the single-plant selections from which the bulk increases were built up. Until 1924 the Senior District Agricultural Officer was assisted only by a Plantation Manager. The total area comprising the farm was in the region of 350 acres, of which 50 acres were planted to cotton in the season 1919–20. The seed farm was increased later to 80 acres (in 10-acre blocks) and in 1924 the staff was increased by the appointment of a Cotton Botanist to take control of cotton breeding. In 1928 an additional cotton breeder was appointed and in 1930 the Cotton Botanist was transferred to Bukalasa to initiate the work of improving the strains of cotton for the elephant grass areas of the Protectorate. Up to 1930, therefore, Serere was the only station for the selection and increase of improved cottons for the whole country, and the strains N.17 and S.G.29 were both bred there.

Although a certain amount of instruction in agricultural methods had been imparted to natives, selected for posts as agricultural instructors, since the opening of the farm, it was not until the latter end of 1931 that a systematized programme of agricultural education was started.

As a result of the serious outbreak of black arm disease of cotton in 1929–30 the Mycologist was posted to Serere in 1932 for one tour. A permanent Entomologist was added to the staff in 1935. In 1936 the Senior Chemist was also posted to Serere to study soil erosion problems. It is hoped that ultimately, visiting laboratories, equipped with gas and water, will be built at Serere in order that specialist officers may be enabled to study special problems on the spot.

From the first the farm has been run entirely with ox and hand labour in conformity with the usual native practice in the short grass areas of the country. Continuous cropping with cotton and food crops, however, led to serious soil deterioration which was hastened by the extra ploughing, cross-ploughing and harrowing necessitated by a green-manuring programme. Sheet erosion took place to such an extent that in 1933 the old farm was given over entirely to soil regeneration experiments, new land being taken in for the seed farms. The experience gained in the running of the old farm was of great value in planning the new farms. These are all provided with bunds to check erosion. The old green-manuring programme has given place to a definite resting period under a grass cover, and all ploughing and planting is along the contour.

The rotation is:—

1st year, Autumn: Cleared from bush and planted to Stizolobium.
2nd year, Spring: Cotton.
3rd year, Spring: Groundnuts or *wimbi*.
Autumn: Planted with grass.
4th, 5th and 6th years: Grass.
7th year, Autumn: Reopened.

In addition to the seed farms (40 acres), which have to provide seed of improved

cottons to supply the Mulondo segregated area (400 acres), there is an area set aside for the Botanical section's breeding plots, variety trials, etc. This experiment farm is made up of five blocks of ten acres each on which the above rotation is followed except that the resting period is one year shorter and farmyard manure or compost is used. Promising cotton varieties from the breeding plot are increased in two stages (one-fourth acre and three acre) before they reach the main seed farm and these plots are so distributed that no plot is within 200 yards of any other cotton.

The erosion and fertility experiments already described in this journal are also located at Serere.* Experiments in the manufacture of farmyard manure and compost are being conducted. In all, over a thousand experimental plots are harvested and yields recorded separately each season. The total area comprising the farm has increased from about 350 acres in 1919 to about 2,000 acres in 1933.

The Senior Agricultural Officer, whose headquarters are now in Jinja, maintains a general supervision of the work at Serere, but the immediate administration of the station is now vested in the Botanist.

Botanical Section

Cotton.

All the cotton grown in Uganda at the present day has resulted from seed introduced from other countries, and moreover all Uganda's cotton is of American Upland type.

The cotton breeding work at Serere can be summarized under the following headings:—

A.—Selection from already established varieties. Both single plant and mass selection are being practised. In the eastern area the established cottons (N.17 and S.G. 29) are derived from Nyasaland Upland, which in its turn was originally selected from the American Upland type "Floradora".

B.—Single plant selection from newly introduced varieties. The most successful of these is Parnell's U.4.4.2, which has given rise to a number of diverse strains, some of them of great potential value.

C.—Production of new varieties by hybridization. The chief aim is to combine the good lint characters of the Nyasaland Upland types with the high yield and desirable agricultural characteristics of the U.4.4.2 derivatives.

In recent years the principle adopted at Serere has been to concentrate primarily on the selection of agriculturally suitable plants on the following basis:—

(*a*) High yield.
(*b*) Upright sympodial habit.
(*c*) Early maturity.
(*d*) Drought resistance.
(*e*) High ginning percentage.
(*f*) Tolerance to black arm disease.
(*g*) Tolerance to jassid attack.
(*h*) Minimum lint length of 29 to 30 mm.

Having obtained a cotton which fulfils the above conditions, the next stage is to improve lint characters (length, fineness, etc.) without losing any of the characteristics under the headings (*a*) to (*g*) above.

To some people this process of attempting to improve lint characters after having produced a cotton with excellent agricultural characters, may appear to be putting the cart before the horse. In practice it has been found that it is extremely difficult by the ordinary methods of selection to improve the agricultural characters of a cotton possessing superlative lint. Similarly it has

*Martin and Biggs. This *Journal*, 1937, II, p. 371.

been found only too easy to lose valuable agricultural characters when attempts are made to improve the lint. In general the long silky cottons are produced by the more delicate plants and the longer the staple the lower the ginning outturn. It must be realized that Serere is the cotton breeding centre for the short grass areas of Uganda, a term synonymous with areas of light (easily eroded) soils and poor rainfall distribution. It is therefore essential to aim at a hardy plant which will produce a fair crop in the most adverse weather conditions.

Working along these lines some very promising cottons have been produced; a notable example is S.P.84, which is a high yielder with lint little if any inferior to the standard Uganda cotton of to-day and with much higher resistance to black arm. It is probable that S.P.84 represents, or very closely approaches, the optimum combination of agricultural characters and lint length that can be attained by selection from the cottons at present grown at Serere. It is probable that better results may be obtained by the production of new strains by hybridization. This line of attack has only been in operation for three years but there are indications that it will lead to a better product than that obtained by either single plant or mass selection.

Food crops.

In addition to the work on cotton the section is also concerned with the selection of the food crops *wimbi* (*Eleusine coracana*), sorghums and groundnuts. Promising results are being obtained.

Education Section

African Agricultural Assistants.

Students from Makerere College taking more advanced courses in agriculture spend one of the last two years of their training at Serere. During this time their work is almost entirely practical. They receive training in the general running of the farm, plot work and soil management. They are allocated on a monthly roster to all phases of the work of the farm and given a certain measure of responsibility. For instance, in any one month one student would be in charge of ploughing, one in charge of the herd of working oxen, others assisting in marking out plots for new experiments and others harvesting experimental plots. Thus not only do they obtain insight into farming methods but also learn how to organize and control labour gangs. On the completion of the five years' course those who pass out successfully are appointed to African Civil Service posts within the department.

Small Holders.

Finally there are six small holdings on the farm. Three of twelve acres are each worked by a family group (three pupils and their wives). Two eight-acre holdings are each worked by a single family unit and one twenty-acre holding is worked by ten bachelor pupils. The pupils are selected in the districts concerned and spend two years at Serere, during which time they do all the work of the holding. Each homestead comprises a house, food stores, covered kraal and implement shed. Working oxen, cows, poultry and implements are supplied. The pupils are taught the manufacture and use of farmyard manure and run the holdings on a definite rotation which includes a 50 per cent resting period under grass. The course is almost entirely practical and at the end of two years the successful pupils are given land, and (in some districts) an advance to build their house, kraal, etc., and to buy implements and cattle. Of the pupils already trained not all have been successful on their own land, but with some the results have, on

the whole, been encouraging. It is too early to judge the results of these courses but it is hoped that the holdings of pupils trained at Serere will prove to be useful foci for the dissemination of knowledge of better farming methods in the districts.

Agricultural Instructors.

Candidates for employment as District Agricultural Instructors are also trained at Serere, receiving instruction in soil management, laying out and measuring plots, recognition of plant pests and diseases and the writing of reports. Recently an annual refresher course for instructors has been instituted and an opportunity is thereby afforded for further training in those subjects which appear to present difficulties.

Schoolmasters.

During the year, a course, of two months' duration, is held for primary, elementary and selected sub-grade schoolmasters. The course, which is based on practical study, includes the subjects of elementary botany and soil chemistry so as to provide a foundation for the lectures on the maintenance of soil fertility, the recognition of pests and diseases, and the running of school farms.

General.

The station is provided with a lecture room, quarters for pupils, and a school garden, in addition to the self-contained small holdings.

ENTOMOLOGICAL SECTION

Since August 1935 an Entomologist has been permanently stationed at Serere for work on cotton pests. His work has been specially concerned with the sucking insects which attack cotton, namely *Lygus* (and related capsids), jassids, stainers, and *Helopeltis*. A special jassid-proof insectary of "Staybrite" steel wire was erected in 1936, primarily for the study of jassid resistance and the effect of jassid infestation on yield. Observations in the field during the past three seasons indicate that with the cottons at present grown, jassids are not a major pest in Uganda, and in future the insectary will probably be put to other uses; but it will always be an invaluable asset for any entomological work in progress. Work on jassids has mainly consisted of population counts to obtain exact data on the seasonal incidence of this pest and on the relative resistance of the various strains with which the Botanist is working. These counts have now been standardized, and will probably be continued as part of the routine observations for a few more seasons, until adequate data on the subject has been accumulated.

A considerable amount of attention has been paid to the relative resistance of varieties to the pests in question, and it is hoped that this work will be of assistance to the Botanist. Great differences between varieties have been demonstrated in susceptibility to *Helopeltis*. On the other hand there would appear to be little hope of finding marked differences between varieties in susceptibility to *Lygus*, though some recent strains show more divergence in this respect than was first suspected to be likely. *Lygus* is perhaps the worst pest of cotton in this part of Uganda, and has so far proved rather intractable, in spite of the considerable amount of attention it has received; it is evident that much work remains to be done on this pest. Observations on stainers have chiefly consisted in a study of their alernative host plants, and in recording the seasonal infestation on cotton. The causes of staining in cotton are another problem which demands attention; preliminary observations have indicated that, at least in some seasons, stainers are not the principal factor

involved, and that bollworms, especially the Uganda Red Boll (*Argyroploce leucotreta*), may be the most important cause.

General Agronomy

In addition to the work already described the work of the station has been extended to include general experiments not connected with the breeding and seed increase programme. Rotation and erosion experiments were conducted during the period 1929–33 and were succeeded by the comprehensive fertility and erosion experiments already described in this journal. Manurial trials, a ridge-planting experiment and cassava variety trials and soil regeneration experiments on the old farm are also being conducted.

Stock in an Alternate Husbandry Farming System

RESULTS OF RECENT INVESTIGATIONS IN THE NAKURU DISTRICT

By R. S. BALL, *M.A., Dip. Agric. (Cantab.), A.I.C.T.A., Agricultural Officer, Kenya Colony*

In the predominantly arable areas, alternate grass and arable farming is becoming the basis of the system, and this tendency is most pronounced where the establishment of pasture on arable land presents a little difficulty.

One of the chief advantages of such a system is the provision of grass of greatly increased stock-carrying capacity, which lessens the amount of walking that the animals have to do. This will in turn be reflected by increased output. The essential feature of such a rotational system is that all the manure made by the animals should be returned directly to the land, so that fertility may be restored within a reasonably short space of time and the land made available again for arable cultivation. In order that maximum use may be made of all the manure of the grazing animals, it is necessary that portable buildings, milking bails, calf pens, sheep bomas and pig units, should be used so that wastage and handling expenses will be reduced to the minimum. It is probably only the smaller farm which is able to cart manure to the land at an economical rate; on the larger farm manuring will not be an economic proposition, unless the manure is applied directly by the grazing animals. The practice of alternate husbandry is extending rapidly in almost every country in the world as its value becomes more generally recognized. Experiments carried out in this country have shown that under certain conditions, even on worn-out arable land, established pastures can carry one beast per three-quarters of an acre compared with one beast per six acres for ordinary veldt in the neighbourhood. Apart, however, from largely increased stock-carrying capacity, the use of land that is under grass for relatively short periods has additional advantages, since the land is kept reasonably clean of worms (particularly important for sheep) and is managed intensively enough for grazing to be controlled without the use of fire. In addition, damage to grazing and erosion of the soil due to tracking to and from permanent buildings are eliminated.

The extent to which such a system can be practised is of course largely controlled by the amount of arable land available, since there is on almost every type of farm a certain acreage of land which is suitable only for rough grazing and which can be utilized effectively with store stock. In addition there are certain difficulties that must be overcome before such a system can be effectively practised. The chief of these is probably fencing, since, for the efficient utilization of the grassland, fencing into small areas is desirable, in order that the grazing may be fully utilized. Portable electric fences may partly solve this problem. Equal in importance to the problem of fencing is that of water, and more extended facilities in this direction could be provided by the construction of dams, which can be filled with water from road drains, contour ridges on the arable land, etc. Thus constant tracking to and from permanent sources of water can be avoided, at least during the wetter months of the year.

A further objection frequently levelled against rotational grass and arable farming is the difficulty experienced in ploughing up and eradicating the grasses when

it is intended to bring the land back into cultivation. In practice, however, the majority of them are not difficult to eradicate in a dry season, with the exception of Kikuyu grass, which in many areas can be replaced by shorter-lived grasses suited to temporary leys. Although the breaking up of the land will entail expenditure, that will be justified by increased crops due to the restored humus content of the soil and reduced soil erosion.

In the high-altitude areas (over 8,000 feet), the problem of the grass species most suited for planting for short-term leys is probably more difficult than in the lower areas, although at the higher limits mixtures of the English grasses and certain Australian grasses, such as *Phalaris tuberosa*, have given promising results.

The appendix gives the chief different types of herbage which can be encouraged by arable cultivation and subsequent planting or reversion in the chief mixed-farming areas. Results to date have shown that there are very few areas in the country where the grassland cannot be greatly improved and its stock-carrying capacity increased by the use of the plough.

While the stock-carrying capacity of such pastures is considerably greater than that of unimproved grazing and the grazing season is prolonged into periods of drought and scarcity, there still remains a need for forage and fodder crops to tide over these adverse periods, more particularly as there is no reserve of coarse grass under a system where close paddocking is practised. Emphasis must again be laid on the need for proper fodder conservation. Some progress has been made in this connexion and methods of feeding at low cost have been devised. Stress must again be laid on the fact that it is useless to give supplementary feeding, except in adequate quantity. Most of the farmers who claim poor results from supplementary feeding fail because they do not feed in sufficiently large quantities. The problem must, however, depend largely on the amount of feed that can be grown on the farm itself.

Cattle

The dairy herd will of course occupy the most important place in the unit and will take precedence for the available grazing. It is essential that the whole unit should be portable, i.e. milking bails, separator house and calf pens, the latter consisting of small thatched pens each 5 ft. × 4 ft. in size in which each calf is housed individually. This ensures that they will not suck each other, and enables control over disease to be exercised. Such pens can be moved frequently to fresh sites. The milking bails should be regarded as simply for milking and the feeding of concentrates since the cattle seldom have sufficient time in which to eat roughages, such as hay and silage, during the few minutes which it takes to milk them. Farmers frequently state that unless the cows can be fed individually when tied up, a number of them will be horned away by the larger and stronger cattle and will fail to secure food. This seldom happens if the food is spread in a long line on the pastures so that all have plenty of room.

The chief roughages likely to be available for the dry season will of course be silage and hay. Experiments have been undertaken at Njoro to devise the most suitable form of silo for the dairy farm and certain results are available. It would appear that the best type is a round deep hole in which considerable compression can be secured and a large volume of material stored. This is best lined with stone if the soil is not such that it retains

its slope easily. Expenditure on such permanent pits (which should have a diameter of 15 ft. and a depth of 20 ft.) is well justified and it is always desirable to have several so that there will always be one in reserve for use in case of unexpected drought. They should be covered with a thatched roof and the material can be lifted out by a pulley block and tackle. Such silos are, of course, most useful on the small farm, but on the large arable farm, a temporary type may be desirable so as to enable the material to be ensiled near to where it is grown and will ultimately be fed. Experiments have therefore been carried out with the use of sisalkraft silos which are readily movable. They have, however, certain disadvantages. In the first place, they are relatively expensive owing to the short life of the sisalkraft, which does not appear to exceed the period of ensiling one crop. Secondly, it appears to be essential to ensile chaffed material only, because long material apparently cannot be compacted enough to avoid entry of air between the layers of sisalkraft. Thirdly, considerable wastage is likely to be experienced. The construction of these silos is, however, simple, a circle of cedar posts being placed in the ground at intervals of 4 ft. and connected with strands of fencing wire 18 in. apart. Sticks are twisted between the wires and the sisalkraft is laid round as the silo is filled, being overlapped at least 1 ft., since it shrinks considerably as the material settles. A more expensive silo can be constructed by the use of Snow fencing in place of the wire and sticks, and this type is probably more satisfactory. A hatchway is left about 3 ft. wide to permit of filling and this is covered with planks as filling proceeds.

For those farmers who are reluctant to build silos and whose soil does not permit of the construction of temporary pits owing to the likelihood of the entry of seepage water, good silage can be made in stacks. Oats are the crop most suited for the manufacture of stack silage since they compact readily and do not require chaffing. Material such as maize and Napier grass is unsuitable for stack silage since it does not compact sufficiently readily to exclude air. The stacks should be built in a sheltered place not exposed to a drying wind, should be round and have a diameter of at least 20 ft. They should be kept well heaped in the middle when building and when finished be thatched with a thick layer of grass and then heavily weighted with either soil or stones. The sides should, however, first be pulled by hand so as to get rid of all loose material and if possible trimmed with a hay knife. In this manner air is excluded as far as possible. While a certain amount of wastage will occur on the edges of such stacks, excellent silage can be made. They have the further advantage that their cost is negligible and that they can be built next to the field where the crop is grown or will be fed.

Silos of the types described above may be a very desirable accompaniment to the rotational system of arable farming, since the material can be fed without transport. The stack silo is cut in several wedges downwards with a hay knife. The material should be scattered in lines in the paddocks so that the milking cows can feed over a considerable period. It is best given in the evening so that it will remain succulent during the feeding period.

A considerable range of crops suitable for silage has been tried during the past few years. While maize remains pre-eminently suited for the maize-growing districts and oats for high-altitude areas, and for areas where the rainfall is not sufficient for maize, or the silage crop

can only be planted after the bulk of the cash crops have been sown, yet Napier grass offers distinct possibilities in addition. It is particularly useful since it is a crop which does not require annual cultivation and furthermore may be grown on contour banks to bind them and help to prevent erosion. Or an area of worn-out land may be planted in order that it may recuperate under the grass with grazing cattle.

In order to make satisfactory ensilage from Napier grass, it appears necessary to chaff it into lengths 4 in. to 6 in. long and add sugar-containing material during the process of ensiling. 1 to 1½ per cent of molasses by weight of green material ensiled has proved most suitable for the purpose. One part of molasses should be diluted with three parts of water, well mixed, and watered on as the grass is chaffed and trodden. The mixture should be very well compacted by heavy treading, and great care used to keep water out of the pit, since Napier grass can be soured more readily than other silage crops. Where molasses are expensive owing to long rail transport, the use of 10 per cent by weight of Uba sugar cane is recommended. This crop can be grown successfully in the lower altitude areas and will provide a cheap substitute for molasses, though not quite so effective. Pits should not be opened for two months after ensiling, as Napier grass appears to take rather longer to mature than other silage crops.

The need for a leguminous hay crop to take the place of lucerne in areas of excessive rainfall or where soils are not suited to its cultivation has resulted in the extensive cultivation of varieties of Vetch, particularly the Purple and Hairy. These, besides helping to provide an excellent hay crop exert a recuperative effect on the land and are useful in a crop rotation. Their only drawback is that they are somewhat slow in maturing and so should be sown with the first rains. The crop should always be cut when it is commencing to flower, otherwise it tends to become woody at the base and unpalatable to stock. Yields of four tons of hay per acre are by no means uncommon with the purple variety. The crop requires considerable time to dry and is slow to make into hay. For this reason it is best stacked in the field around tripods (which can be made from three gum poles about 10 ft. high), to ensure a good circulation of air. If possible, the material should be raised about 10 in. off the ground on a rack constructed on the tripods. By this means it is unnecessary to turn the crop while it is making and thus the green colour and flavour are preserved.

Concentrated Feeds

The most important of these is probably sprouted grain which can be regarded as both a succulent and a concentrated feed. It provides a ready and cheap means for rapidly supplementing food-supplies when other sources fail. The preparation of the grain under Kenya conditions is a relatively simple matter, particularly in the case of barley and oats, the former of which is usually cheaply available on the arable farm. The increase in bulk of four to four-and-a-half times the grain used and the simplicity of preparation are added advantages. The preparation of this product has already been described fully (this Journal, Vol. III (3), page 180) and its utility as a feed demonstrated during the last dry season, when it was found that it could be fed safely in quantities up to 8 to 10 lb. daily to milking animals and in smaller quantities for rearing stock. Recent experimental work carried out in England has confirmed the value of this feed, both as a milk producer and as a supplementary feed for

fattening animals. It cannot however be regarded as suitable for feeding by itself, but should be supplemented by concentrates in small quantities.

Cottonseed

Cottonseed, which is becoming available in increasing quantities, provides a protein-rich food at low cost, but unfortunately it has several disadvantages. In the first place it is usually covered with a heavy coating of lint, which is of low digestibility, and secondly it is not suitable for young stock, bulls or animals near calving. Thirdly, it should not be fed in excess of 4 lb. daily to milking animals, otherwise it is liable to make the butter tallowy. Subject to these provisos, however, it provides a cheap and useful protein-rich feed which can be mixed with various concentrated feeds to make balanced rations. Examples are:—

A. 2 parts cottonseed (parts by weight).
1 part bran.
1½ parts crushed barley or maize meal.

B. 1½ parts cottonseed (heavy milkers).
1 part groundnut and sim-sim cake.
1 part bran.
2 parts crushed barley or maize meal.

Rice Dust

This is another cheap feed, which is becoming available in large quantities as a by-product of the rice milling industry. It is a starchy feed, with a fairly high mineral content and is suitable for feeding to dairy and beef stock as a constituent of concentrated rations. It tends to have a laxative effect if fed in excessive quantities, but is a useful dry-season supplementary feed.

Suitable rations for dairy cows containing this feed would be as follows:—

1 part cottonseed (parts by weight).
1½ parts rice dust.

For heavy milkers—

1 part cottonseed.
1 part bran.
1 part groundnut and sim-sim cake.
1½ parts rice dust.

It can also be used as a component of the ration for a variety of stock, including poultry, and pigs other than fattening stock. For the last it is unsuited on account of its tendency to make the fat oily. It is likely to become available in increasing quantities in Kenya and should prove particularly useful to farmers during periods of high grain prices.

Pigs

There is a considerable scope for improvement in Kenya pig husbandry. One of the chief methods by which this can be effected is by the use of portable arks in which sows dry and in-pig and suckling are housed and allowed free range on grassland. The damage which pigs do in rooting up grassland will be unimportant if the land is shortly to be ploughed again. In this manner economy in feeding is secured and the pigs, particularly suckling and weaners, are kept free from worm infestations. The arks used should consist simply of a pent roof which reaches to the ground and should be half-floored to allow the sow a dry place on which to lie when suckling.

When the pigs are weaned they should be removed to permanent buildings for fattening since the amount of exercise obtained under the ark system is too great for quick maturity. Stricter economy is required in feeding pigs than at present obtains on many farms in the colony and if weighings show that more than 3 to 4 lb. of meal mixture (barley meal, maize meal, pollard, meat meal, bran, etc.) is required per pound increase in live weight, it is necessary to review the feeding and breeding of the stock. This figure should be much reduced if skim

milk or buttermilk is available. Pig-feeding costs could be reduced appreciably on many farms if greater use was made of the buttermilk which is available cheaply from the creameries. Certain precautions should however be observed in the feeding of buttermilk to pigs. It should either be fed fresh or kept in clean vessels and fed within three days. It has then practically the same feeding value as skim milk, and can be fed in the same quantities. If it is soured in dirty vessels it is likely to cause scouring and digestive troubles. One of the obections raised against its more extended use is the fact that supplies are irregular and therefore it is difficult during periods of scarcity to maintain pig production. A seasonal variation in pig output will, however, be of less importance as export outlets become available and, if necessary, a supply of lucerne leaf meal to the extent of 10 to 15 per cent by weight in the rations can be used for short periods. It is not always appreciated that the feeding of skim or buttermilk to pigs will enable feeding costs to be reduced very appreciably in respect of the other feeds used. These can be compounded largely of home-grown feeds, such as barley and maize, without the purchase of wheat offals, these being necessary only when milk products are not available, and for suckling sows and weaners.

Stress should again be laid on the fact that good housing is essential for economy in food and low costs of production and that dry sows, boars, in-pig sows and suckling sows in movable arks on the grassland assist in restoring fertility, but that weaners and fattening stock should be housed in permanent houses with stone or concrete floors and movable wooden racks for the pigs to lie on. At the present time the loss due to housing is very considerable in this country and is frequently not appreciated. Apart from slower feeding, due to cold and damp in inadequate buildings, worm infestations are usually high unless proper flooring is provided, and hence the maturity of the pigs is delayed.

Poultry

The success of folding poultry over arable land has now been demonstrated in Kenya and the value of young protein-rich grass as a good supplement clearly indicated. The system is considerably simplified when the poultry are folded over grassed-down arable land, since the units are easily moved and the minimum damage and strain caused, the surface of the ground being more level than ordinary veldt. The birds' scratching improves the grassland considerably and their dung restores fertility to the land. It has been found, particularly during the rains, that it is necessary to cut down the protein normally fed to the birds owing to the high content of the young grass, and this enables production costs to be lowered since protein is usually the most expensive item in the ration. In extreme cases, it has even been necessary to move the units to poorer grazing because the digestion of the birds was upset by the high quality of the grass. The system is best confined to laying stock and breeding birds should be allowed free range in order to secure high fertility in the eggs. One unit comprising twenty to twenty-five laying birds will cover half-an-acre annually if moved every other day, so that on the smaller farm poultry should provide not only a valuable addition to the income, but also a useful means of helping to restore the fertility.

Sheep

It is probable that the medium-altitude mixed-farming areas are difficult for sheep farming because they do not embrace either the cold conditions of the

high areas or the dry hot conditions of the lower sheep-ranching areas. They are intermediate, with the result that worm infestations are likely to be heavier than in the districts where sheep are at present largely run. In a system of alternate husbandry, however, these difficulties are to a large extent overcome, since the rotation of arable and grassland ensures that the land is kept free from worms.

In order to make the fullest use of the grazing, sheep should follow the cattle and there is a considerable scope for their extension on the mixed farm. Opinions differ as to the best method of starting a flock, some farmers favouring the purchase of maiden ewe hoggets and others the purchase of old draft ewes. Unless conditions are exceptionally favourable, it usually pays to purchase the young stock, since they acclimatize more readily and breeding life is ensured. It is essential to rotate grazing carefully for the sheep and they should always follow cattle rather than accompany them. Many of the failures to secure successful results in these medium-altitude areas are due to the fact that inadequate attention is paid to this factor and the sheep graze on stained ground. Weaning lambs and fattening wethers should be allowed access to the pick of the grazing and the milk flow of suckling ewes can be greatly increased by the feeding of silage, at the rate of about 5 lb. daily. Napier-grass silage has been proved to be suitable for the purpose, although oat silage is probably ideal. Silage is probably superior to a corn ration, since it stimulates the milk flow better. Sprouted grains can also be fed to sheep in small quantities and are particularly suitable for fattening stock in the dry season.

An attempt has been made in this article to indicate the importance of mixed stock farming in the arable areas. It is almost as important to avoid concentration on one branch of stock farming as it is to avoid single-crop farming, since the fullest use cannot be made of available grazing and feed unless several kinds of live stock are maintained. At the present time the live stock on the mixed farm consists largely of dairy stock, to the exclusion of other branches which should be of almost equal importance.

APPENDIX

Reversion of Arable Land in Mixed Farming Areas

High Altitude: 8,000–9,000 *ft.*

A. *Natural Reversion.*

Mixture of—

Kikuyu grass.

Blue couch (*Digitaria* spp.).

Indigenous white clover.

Relative proportions of these grasses will vary with amount of humus and fertility of the soil, Kikuyu grass predominating on the richer soils. After a few years, if the land is not cut, heavily grazed and controlled, *Eleusine jaegeri,* a useless grass, will appear. The appearance of this grass is an indication either that the land should be manured more heavily by stock concentration or else reploughed.

B. Sown pastures.

At the higher limits in these areas, temporary leys comprising mixtures of *Phalaris tuberosa,* Italian Ryegrass and Cocksfoot can be established. They are of short duration owing to the incursion of the indigenous species, but the ease with which they can be eradicated is of value if the land is to be reploughed within a short period.

Medium Altitude Areas: 6,500–8,000 *ft.*

A. *Natural Reversion.*

Mixture of—

Cynodon spp.
Digitaria spp.
Kikuyu grass.
Hyparrhenia spp.
Trifolium johnstonii.

On lighter soils Rhodes grass (*Choloris gayana*) forms part of the herbage and on the Menengai ash soil-type will, together with Kikuyu grass, constitute the bulk. At the higher limits of this range on rich forest soils Kikuyu grass will form the bulk of the herbage and therefore for these limited conditions alternate husbandry is seldom possible on account of the difficulty of eradication.

B. *Planted grasses.*

Australian Rhodes grass for short-term leys or mixtures of Australian Rhodes grass and *Paspalum dilatatum.* For longer ley Star grass species, usually those indigenous in the area.

Low Altitude Areas: 6,000 *ft.*

A. Natural reversion produces a mixture of *Cynodon* spp. and indigenous white clover (*Trifolium johnstonii*), and as a complete cover of these *Cyndon* spp. is obtained the *T. johnstonii* tends to die out. A percentage of indigenous Rhodes grass is usually contained in the herbage and the amount will vary with the nature of the soil.

B. In these areas Australian Rhodes grass, Molasses grass, *Amphilophis pertusa,* might be used for temporary leys, but it is probable that equally useful results are produced by natural reversion.

The Sukuma System of Grazing Rights

KNOWN LOCALLY AS *KUPELA ISESO* OR *NGITIRI*

By H. C. SMITH, *Assistant Live Stock Officer, Tanganyika Territory*

In Tanganyika Territory the measure that is expected to go furthest towards checking soil erosion due to overstocking is the institution of deferred grazing, or rotational grazing as it is more frequently called. The essence of this system as applied to native-owned stock is that the grazing land of any area shall be divided into two portions: a less erodible for grazing during the growing season, and a more erodible for grazing only during the dry season. Carried out as the Veterinary Department would like to see it, the wet season grazing of Sukumaland would consist mainly of flat land—the so-called *mbugas*—which is almost non-erodible and can be made available to stock by provision of shallow dams wherever more permanent sources of water are lacking, while the dry-season grazing would be the cultivated and adjoining land, often on slopes, near the villages and permanent water.

One of my tasks during the past year has been the promotion of this system of rotational grazing among the Wasukuma, and I found that although many objections were raised to the sending away of cattle to *mbugas* in the rainy season, none was raised to the reservation of considerable areas of eroded land for use only in the dry season after the grasses had seeded. This, I found, was due to such a form of reservation being already well known to the Wasukuma.

A native of Sukumaland lives and works on the land at the will of his chief, in that so long as he obeys all lawful orders and does not create a nuisance he cannot be ejected from his home and the land upon which he lives.

The chief is represented in the village area by the *manangwa* who is directly responsible for all the matters affecting his village and the people who live there. A village under one *manangwa* is split up into smaller sections called *kibanda*, each formed of a varying number of small clusters of houses built on the top of rising ground.

The people of the village select from amongst themselves their own representatives, known as *Wasumba batale*, and their duties are many. They carry the message from the chief through his *manangwa* to the people and vice versa, they act as witnesses at the payment of cattle in bride price and are consulted on all matters affecting the group of *kibanda* they represent. They are not paid a salary but are always included in the distribution of meat when an animal is killed for ceremonial purposes, their share always being the neck and head portion of the animal.

One of their many duties is to select the building plot of any man who desires to build in their area and to satisfy the people that the man is of good character. When the house is built the owner encloses a small area with a living fence which is generally of *manyara* (*Euphorbia tirucalli*), and which is called *igobe* within which area he has absolute right of occupancy. Again with the help of the *wasumba batale* he selects an area immediately adjoining his *igobe* on which he wants to plant food crops sufficient for his own needs, and this is known as the *itongo*. He has the sole right to plant any food crop within the *itongo* and no man can come in and plant there without his permission.

The boundaries of the *itongo* are determined by the limits of the food plots, but the land in the *itongo* which is not planted is demarcated by hoed-up heaps of earth, the *iseso,* at about ten yard intervals. The area of uncultivated land so enclosed is known as the *ngitiri* and is recognized by all as private land.

The *ngitiri* is now used as an area of reserved grazing from planting time until after harvest and may be used only by the occupier of the *itongo* as he wishes. He may reserve it entirely or use it during this period for the calves whilst his cattle seek communal grazing within the village. Natives who own no cattle have their *ngitiri,* which is used to protect food plots and to provide thatching grass. After harvest the land can be grazed over by any cattle of the village. It can be seen that the *ngitiri* originated in the allocation to individuals of land sufficient for the production of food crops with something over for reserve or from which thatching grass could be cut. With increase in cattle, however, the *ngitiri* has come to be looked upon as a grazing reserve.

It may happen that a man attempts to place his *igobe* or *ngitiri* across a cattle path. If this happens the *wasumba batale* collect all the cattle wishing to use the path and walk through the area at the head of the cattle each day until the man realizes that it is against the wish of the people that he should close the road and so he desists. He cannot claim any compensation for damage to property that this action may have caused.

The introduction of rotational grazing is leading by popular consent to the reservation of village *ngitiri* as opposed to reservation of individual plots. The village *ngitiri* is selected by the people through the *wasumba batale* and the *manangwa* and is entirely reserved against cattle during the whole of the time from planting to harvest. This area naturally contains big areas of planted ground and so the planters have no fear of damage by cattle. In one or two villages in Maswa the whole area covered by the *itongo* of one *kibanda* has been declared an *ngitiri* and during the close season cattle going through it to grazing must keep to the paths. Development along these lines may eventually lead to the dropping of the individual *ngitiri* and the litigation it involves, in favour of the bigger unit, but whether it will induce cattle owners to seek much more distant grazing during this close season than they do at present remains in doubt. If in general use, however, it will tend to protect the more erodible pastures from damage through overgrazing.

Variability in Yield of *Coffea Arabica*

By S. M. GILBERT, *B.Sc. (Lond.), N.D.A., Dip. Agric. (Wye), Chief Scientific Officer, Coffee Research and Experiment Station, Moshi, Tanganyika Territory*

INTRODUCTION

This article describes the records in kilogrammes of cherry per tree of a block of about five hundred trees over a period of four years. The objects of this detailed recording are several. Firstly, to build up data on which ultimately an understanding of biennial bearing may be reached; secondly, to enable uniformity trials to be carried out and thus gain knowledge of a correct technique for field experiments; and thirdly, to obtain selections of desirable trees. Whilst it is difficult to avoid technical terms it is hoped that part at least will be of interest to the practical man.

MATERIAL

The coffee is mainly Bourbon type of *Coffea arabica* with a few Kents "supplies". The main block was planted in the field as nine months' old seedlings in February 1925. It is thus about thirteen years old. It is planted on the square, eight feet by eight feet, grown on the single stem system and topped at about six feet. There is scattered shade consisting of *Albizzia maranguensis, Grevillea robusta* and *Annona* spp. The altitude is about 5,000 ft. with a rainfall of between 70 and 80 in. annually.

THE YIELDS

These are summarized in Table I below. The coefficient of variation is a measure of the dispersion of the individual tree yields round the mean. Compared with other crops these percentages are very high.

TABLE I

YEAR	Kilogramme Per Tree Mean	*Clean Coffee Cwt. per Acre	Co-efficient of Variation
		Cwt.	*Per cent*
1934 ..	5·28	10·9	72·2
1935 ..	0·99	1·5	125·7
1936 ..	4·00	7·4	62·0
1937 ..	0·54	0·5	169·5
Mean of 4 years	2·71	5·1	—

*Calculated at 690 trees per acre and 17 per cent clean to cherry.

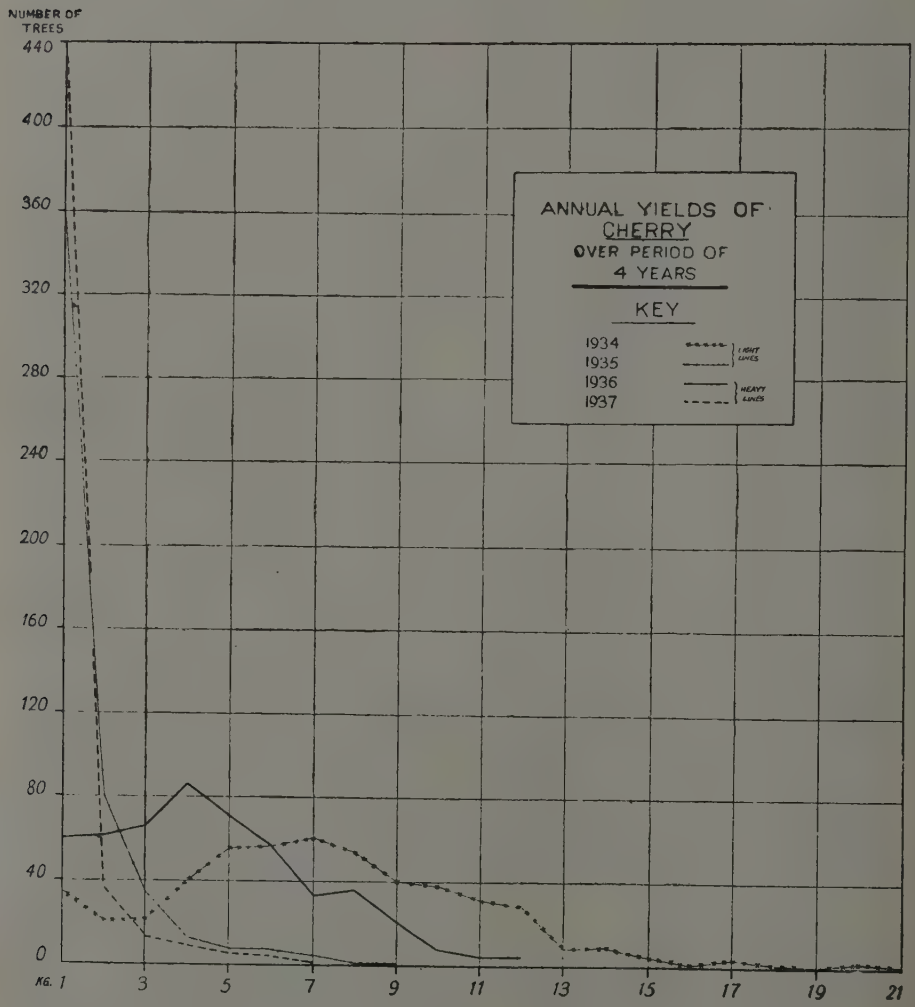
Graphs 1 to 4 based on frequency tables set out the distribution of yield for the period.

The "off" years are pronouncedly so as indicated by the two "skew" graphs for 1935 and 1937. Most trees in these years fall in the class giving less than two kilogrammes. The good "on" year more nearly approaches the "normal" curve.

(*a*) *Biennial Bearing.*

Diagram I is a composite picture of the four years made up of small graphs showing the annual yield of each tree. The horizontal dotted lines indicate the mean block yield for four years. Several points are outstanding. Firstly, pronounced biennial bearing is evident but not always for the same year. Neighbours differ in being out of step, cf. K9 and 10 and L9 and 10. Nevertheless 1934 is very definitely the "on" year. In only a few trees has 1936, although generally speaking "on", exceeded 1934 in yield. This is clearly shown by the numerous "h"-shaped graphs. Similarly 1937 is definitely the worse of the "off" years. It

GRAPHS, 1 to 4


NUMBER OF TREES
440
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360
320
280
240
200
160
120
80
40
0
KG. 1
3
5
7
9
11
13
15
17
19
21
ANNUAL YIELDS OF CHERRY
OVER PERIOD OF 4 YEARS
KEY
1934
1935
1936
1937
LIGHT LINES
HEAVY LINES

is noteworthy that 1936 and 1937 were excessively wet years. Knowledge is yet insufficient to explain the causes of biennial bearing but the habit is obviously not due to climate alone.

(*b*) *Technique.*

Methods have been evolved during the past decade which have added considerably to the accuracy with which field experiments may be laid down and included among these is that of Analysis of Variance. In this particular study the Latin Square lay-out has been used with twenty-tree plots [1] set out five by five (*see* diagram).

DIAGRAM II

Rows

Columns

..C..	A	D	B	E
D	C	B	E	A
B	E	A	D	C
A	D	E	C	B
E	B	C	A	D

This lay-out permits of an analysis of the causes of variability such as that due to position and provides an estimate of the "experimental" error.

Table II gives the plot yields of the sixteen plots for the four years, for means of pairs of years and for the four-year period.

TABLE II

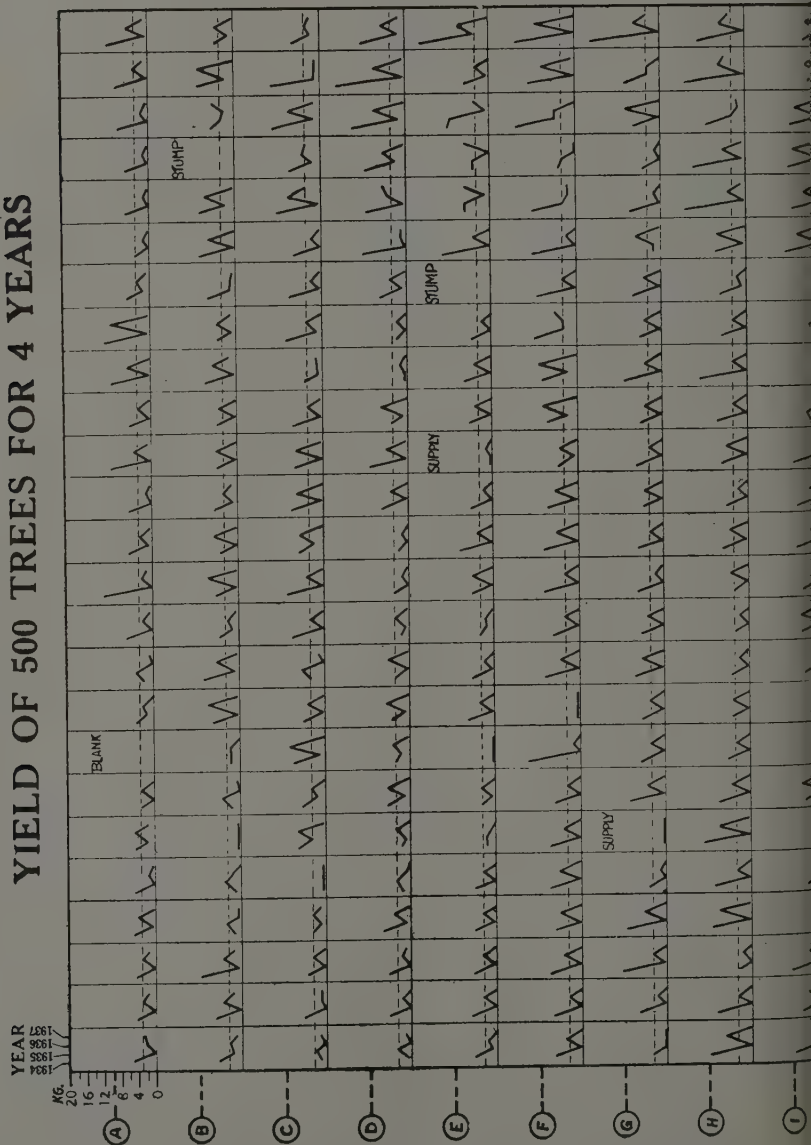
PLOT YIELDS FOR FOUR YEARS

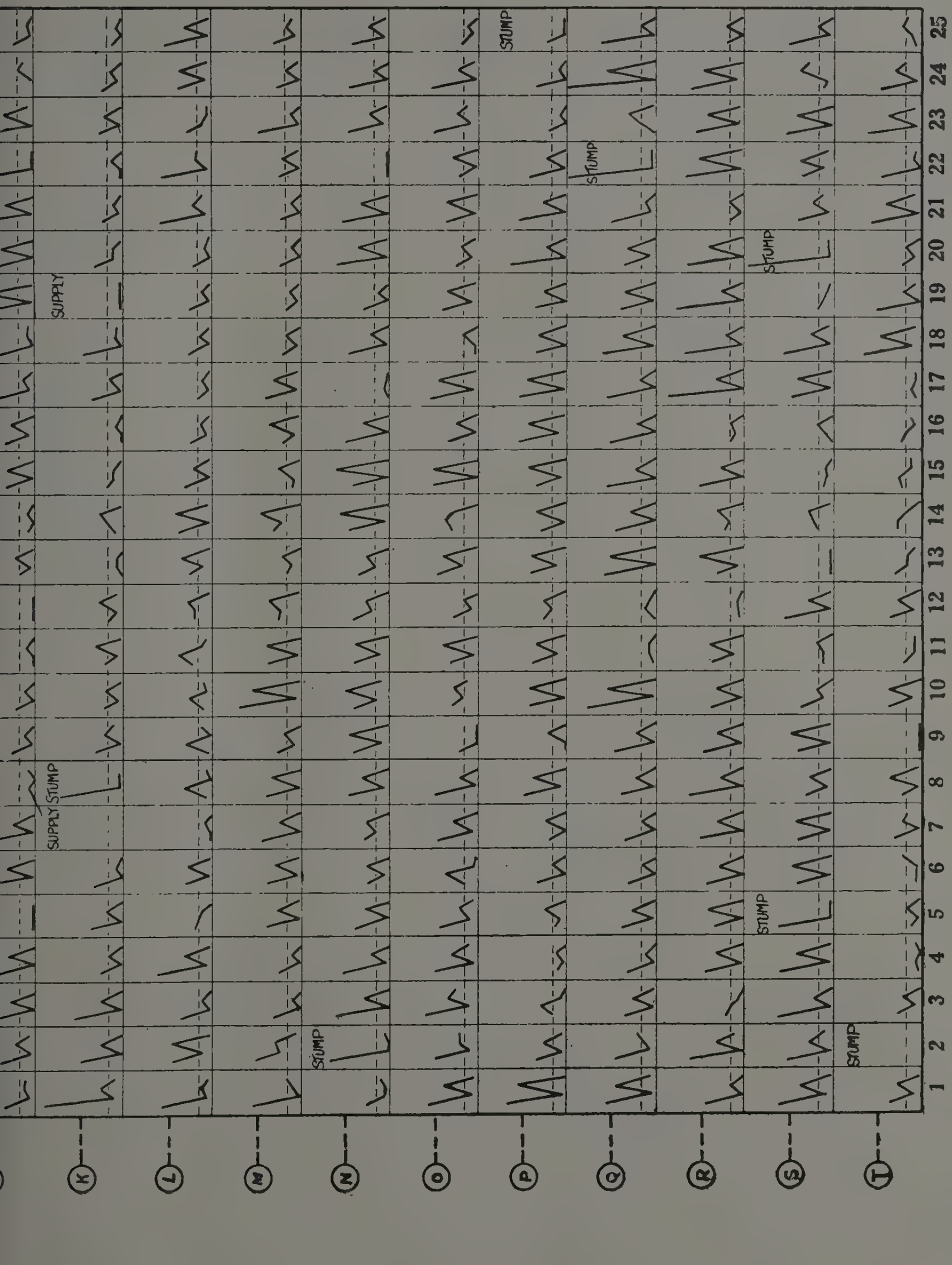
KILOGRAMMES

1934 ..	C 76	A 75	D 115	B 118	E 174
1935 ..	21	31	8	11	17
Mean 1934–5	49	53	61	64	95
1936 ..	42	67	75	68	85
1937 ..	14	3	5	7	22
Mean 1936–7	28	35	40	38	53
Mean of 4 years	38	44	51	51	74
1934 ..	D 125	C 105	B 106	E 150	A 195
1935 ..	4	5	7	11	44
Mean 1934–5	64	55	56	81	119
1936 ..	65	55	68	81	77
1937 ..	2	1	1	6	34
Mean 1936–7	33	28	34	44	56
Mean of 4 years	49	42	45	62	87
1934 ..	B 151	E 94	A 86	D 103	C 133
1935 ..	17	21	23	17	9
Mean 1934–5	84	58	55	60	71
1936 ..	75	52	79	48	80
1937 ..	8	9	3	3	8
Mean 1936–7	42	30	41	25	44
Mean of 4 years	63	44	48	43	58

DIAGRAM I

YIELD OF 500 TREES FOR 4 YEARS




K
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SUPPLY
STUMP

TABLE II—(*Contd.*)

1934 ..	A 165	D 142	E 133	C 141	B 138
1935 ..	28	25	47	11	8
Mean 1934–5	97	84	90	76	73
1936 ..	86	112	142	97	62
1937 ..	22	3	2	0	5
Mean 1936–7	54	58	72	49	33
Mean of 4 years	75	71	81	62	53
1934 ..	E 168	B 143	C 101	A 181	D 185
1935 ..	11	7	34	17	14
Mean 1934–5	89	75	67	99	100
1936 ..	82	105	79	87	101
1937 ..	13	7	6	6	20
Mean 1936–7	48	56	42	47	61
Mean of 4 years	69	66	55	73	80

The same tendencies are brought out as mentioned under biennial bearing. From the point of view of an experiment it is, however, more important that the total for four years of Plots A is 25 per cent more than the similar four years' total for Plots C. It is necessary to try to discover to what this variability is due. The results have therefore been analysed and an attempt made to apportion the causes. It should be remembered that the yields are natural, that is, uniform treatment has been given throughout the blocks as far as possible.

The utility of the lay-out [2] is seen from the amount of variation due to position that is removed by "rows" and "columns".

In an actual experiment the variance due to "treatments" would reflect by comparison with that due to "interactions" the degree to which the plots had responded. The test used is not described here as being beyond the scope of an article written mainly for the planter. In a "uniformity trial" such as this, if the conditions and plant material were ideally even the variance due to "treatments" would be practically nil. Unfortunately the plant material itself is not uniform and the irregularity contributes to the unknown causes of variation grouped under "interactions". It is therefore legitimate in such a trial to combine the two variances, "treatments" and "interactions", to obtain an estimate of the significant differences between mean plot yields that would be necessary when using that block for an actual experiment.

TABLE III

	1934				1935			1936			1937		
	D.F.	Sum of Squares	Variance	½ Log$_e$	Sum of Squares	Variance	½ Log$_e$	Sum of Squares	Variance	½ Log$_e$	Sum of Squares	Variance	½ Log$_e$
Rows ..	4	7,379	1,845	3·76	261·9	65·5	2·09	4,726	1,182	3·54	86·8	21·70	1·54
Columns ..	4	10,660	2,665	3·94	274·4	68·6	2·11	937	234	2·73	792·7	198·18	2·64
Treatments	4	3,235	809 } 625	3·35	1,054·1	263·5 } 168·5	2·79	856	214 } 352	2·68	245·6	61·40 } 47·83	2·06
Interactions	12	6,765	564 }	3·17	1,642·5	136·9 }	2·46	4,778	398 }	2·99	519·7	43·31 }	1·88
Total ..	24	28,039	—	—	3,232·9	—	—	11,297	—	—	1,644·8	—	—
Plot error (percentage) ..			18·9			73·06			23·80			81·83	
Significant differences (percentage)			25·4			97·97			31·91			109·70	

The "significant differences" are mostly due to natural irregularities in yield between plots and must be exceeded in an actual experiment before increases due to treatments could be demonstrated with known probability. It is thus readily seen how useful it is to have previous knowledge of how plots to be used in an experiment are behaving.

It is now necessary to consider the value of more than one year's yield. In this case it is seen (Table IV) that the mere combination of pairs of years considerably helps. Unfortunately, however, once again yields of 1934 and 1935 have exceeded those of 1936 and 1937 so it is still impossible to test out the analysis of the differences between increases of each pair of years. A combination of four years' records make a much more even result.

TABLE IV

	Mean 1934–5				Mean 1936–7			Mean 1934–7		
	D.F.	Sum of Squares	Variance	½ Log^e	Sum of Squares	Variance	½ Log^e	Sum of Squares	Variance	½ Log^e
Rows	4	2,022	506	3·11	1,169	292·2	2·84	1,500	375	2·96
Columns	4	2,348	587	3·19	310	77·5	2·17	889	222	2·70
Treatments ..	4	1,509	377 } 229	2·96	392	98·0 } 111·5	2·29	837	209 } 150	2·67
Interactions ..	12	2,160	180 }	2·59	1,392	116·0 }	2·38	1,558	130 }	2·43
Total ..	24	8,039	—	—	3,263	—	—	4,784	—	—
Plot error (percentage)			20·2			24·2			20·65	
Significant differences (percentage)			27·1			32·4			27·69	

Seasonal effects.—Table V (*a*) analyses the data for the effects of the four seasons on crop yield.

TABLE V(*a*)
ANALYSIS OF VARIANCE

Due to	D.F.	Sum of Squares	Mean Square	½ Log^e	
					Difference
Rows	16	12,452	778	3·3284	0·5404
Columns	16	12,664	792	3·3373	0·5493
Seasons	3	250,078	83,359	5·6651	2·8771
Treatments	4	2,364	841	3·3673	0·5793
Interaction of Seasons and Treatments ..	12	5,425 2,061 } 15,836	264	2·7880	—
Interaction of Parallel Plots	48	13,775			
Total ..	99	294,396	—	—	—

Plot error (percentage) .. .. 29·20
Significant difference (percentage) 18·86

The results are summarized for easy examination in Tables V (*b*) and V (*c*), which are self-explanatory.

TABLE V(*b*)
SEASONS

Yield	1934	1935	1936	1937	Mean	Significant Difference
Rainfall in Inches	46	73	90	99	—	—
Kilogrammes of Cherry per Plot	132·2	17·8	78·8	8·4	59·3	9·38
Percentage	222·9	30·0	132·9	14·2	100·0	15·8

1934 significantly higher than 1935, 1936 and 1937
1936 „ „ „ 1935 and 1937
1935 „ „ „ 1937

TABLE V(*c*)

PLOTS

YIELD	A	B	C	D	E	Mean	Significant Difference
Kilogrammes of Cherry per Plot	65·5	55·5	50·9	58·6	66·0	59·3	10·49
Percentage	110·5	93·6	85·8	98·8	111·3	100·0	17·7

"E" significantly higher than "C" and "B"
"A" " " " "C"

It is seen that 1934 is an outstandingly good year giving about double the yield of the next best, 1936. Pronounced biennial bearing is demonstrated with 1934 and 1936, the "on" years. 1937 is exceedingly bad. The obvious seasonal difference is rainfall, but insufficient data are available to put this down as the definite cause.

It will be noted from (*c*) that the total of four years' yields have given significant differences between plots, that between the best and the worst being over 25 per cent. The block would have been unsuitable for accurate experiments without previous records; plots "E" would have exaggerated the effects of any treatment that might have been applied and plots "C", for example, would have grossly underestimated these effects.

Co-variance.—It would seem possible that since the same trees are being used in the same plots year after year, there should be some correlation between their behaviour in successive years. The method known as co-variance has been used to test this possibility. Table VI sets out the analysis using the means of 1934 and 1935 as the natural-yield years and 1936 and 1937 as the supposed experimental years.

TABLE VI(*a*)

ANALYSIS OF VARIANCE

DUE TO	D.F.	Sum of Squares	Mean Square		$\frac{1}{2}$ Log^e
Rows	4	207	51·8		1·9737
Columns ..	4	655	163·7		2·5490
Treatments ..	4	64	16·0	41·8	1·3863
Error	11	563	51·2		1·9679
Total ..	23	1,489			

Plot error (percentage) 14·81
Significant difference (percentage) 19·96

TABLE VI(*b*)

UNCORRECTED MEAN YIELDS, SETS OF FIVE PLOTS (*See* DIAGRAM II) FOR 1936–7

PLOTS

YIELD	A	B	C	D	E	Mean
Kilogrammes of Cherry per Plot	46·6	40·6	38·3	43·4	49·3	43·6
As a Percentage	106·8	93·0	87·8	99·4	113·0	100·0

CORRECTED FOR PREVIOUS BEHAVIOUR

Kilogrammes of Cherry per Plot	43·2	42·3	42·4	43·8	46·5	43·6
As a Percentage	98·9	96·9	97·2	100·4	106·6	100·0

It is seen (Table VII) that the percentage "significant difference" obtained for the mean of 1936–37, unadjusted for previous behaviour of the plot, was 32.4. When this behaviour is taken into account there is a reduction to 19.9 (Table VI*a*). A very considerable gain in precision.

Using this relationship between previous and subsequent yields of the same plots Table VI (*b*) can be constructed. There is no longer the wide variation in the mean yields of the various sets of plots. The greatest difference, 25.2, has been reduced to 9.7. It is thus very clearly worth obtaining two years' natural yields previous to the application of treatments in an experiment under the conditions described above.

TABLE VII(*a*)

ANALYSIS OF VARIANCE

DUE TO	D.F.	Sum of Squares	Mean Square		$\frac{1}{2}$ Log^e
Rows	4	1,801	450		3·0546
Columns ..	4	4,913	1,228		3·5565
Treatments ..	4	203	51	211	1·9659
Error	11	2,958	269		2·7973
Total ..	23	9,875			

Plot error (percentage) 18·42
Significant difference (percentage) 24·83

TABLE VII(*b*)

UNCORRECTED MEAN YIELDS, SETS OF FIVE PLOTS (*See* DIAGRAM II) FOR 1936 PLOTS

YIELD	A	B	C	D	E	Mean
Kilogrammes of Cherry per Plot	79·3	75·6	70·6	80·3	88·3	78·8
As a Percentage	100·6	96·0	89·5	101·9	112·0	100·0
CORRECTED FOR PREVIOUS BEHAVIOUR						
Kilogrammes of Cherry per Plot	76·8	75·9	77·0	79·7	84·7	78·8
As a Percentage	97·4	96·3	97·7	101·1	107·5	100·0

Similarly even using 1934 alone as the natural yield year and 1936 as the "experimental" year an almost equal gain in precision has been obtained (*see* Tables VII (*a*) and (*b*). Unfortunately, when beginning an experiment, it would not be known, without recording, which was the "on" or "off" year and thus at least two years' natural yields are desirable on adult and apparently uniform coffee when there is definite biennial bearing in the majority of trees and provided that the trees are mostly in step in this respect.

SUMMARY

The paper describes the result of four years' records of yield of 500 trees of *Coffea arabica*.

It brings out the pronounced biennial bearing habit of the block, with the majority of trees "in step".

It demonstrates the unsuitability of such material for field experiments without previous knowledge of yields and shows how the method of co-variance can enable accurate experiments to be done on such material.

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[1] Gilbert, S.M.—"Plot Size," *Trop. Agric.*, Vol. XV, No. 3, pp. 52-55.

[2] Gilbert, S. M.—"Planning Field Experiments," *Trop. Agric.*, Vol. XV, No. 1, pp. 16-18.

A Note on the Cultivation of *Eleusine coracana* in the Misuku Hills

By B. C. G. CHARLES, *C.D.A., A.I.C.T.A., Agricultural Officer, Department of Agriculture, Nyasaland*

The Misuku Hills, in the extreme north of the Nyasaland Protectorate, rise to a height of over 6,000 feet and are broken up by deep valleys, the bulk of the cultivation being on the lower slopes at approximately 5,000 feet. The rainfall varies between sixty and seventy inches per annum and the area generally is one of great fertility, supporting a large population of natives, cattle and goats. Double-cropping is the rule, maize, the staple crop, being invariably followed by beans in the same season, while there is a small native coffee industry.

The cultivation of finger millet (*Eleusine coracana*) is confined to the higher and less fertile slopes on account of overcrowding, and the general practice is to crop a garden for two seasons and then leave it to grass-fallow for two, three, or more years. The heavy burning, common in finger millet cultivation elsewhere in the north of the Protectorate, is not feasible, as all the timber and scrub has been cut out long ago and the fallows are of insufficient duration to permit of its re-growth. Furthermore, the heavy goat population checks natural regeneration and in fact there is a lack of domestic firewood and materials for construction of huts.

The slopes under cultivation are invariably very steep and local ironworkers manufacture a special hoe for use in ridging up these gardens, the blade being some ten inches wide and fourteen inches deep while the handle is from ten to twelve feet long. Ridges, however, are not common in finger millet gardens, but, where made, invariably run up and down the slope of the land, the storm-water running off on the hard subsoil between the ridges with less damage than might be expected.

The variety of finger millet used is a black one and differs from the red types in use elsewhere in the northern areas. It is generally planted in early January, a few weeks after the break of the rains, and matures towards the end of June, being rarely a heavy cropper.

A curious practice is in use with regard to the threshing of the seed. One of the numerous small streams is tapped and the water led into a circular, shallow pond about six to eight feet in diameter. The ripe heads are bundled and immersed, stalks uppermost, in the water, which is allowed to flow extremely slowly through the pond, sufficient bundles having been put in to fill it exactly. The normal period of immersion is four to five weeks, by which time the hull is loosened, but if too much fresh water is allowed to flow through, it does not appear to heat up properly and the process accordingly takes longer. The flow of water can be controlled without difficulty as the rains cease before this retting takes place.

Finger millet prepared in this manner is almost entirely used in the making of beer.

The Consumption of Milk by Europeans in Kenya

By D. HARVEY, *M.A., B.Sc., Ph.D., Medical Department, Kenya Colony*

The activities which are being pursued in various parts of the world with a view to increasing the consumption of liquid milk by all races prompted an enquiry by the Medical Department into the amounts which are consumed by Europeans in Kenya. With this aim in view a small questionnaire was prepared and its distribution was made possible by the active co-operation of a number of milk producers and retailers in the Nairobi district. The thanks of the Medical Department are due to those retailers who approached their customers in this way, and to those of the general public who replied and gave the information asked for. An extension of the enquiry to the Mombasa district was possible as a result of assistance given by the Medical Officer of Health there, and similar acknowledgment of that help is made.

From these sources data have been obtained from 549 households on the amount of milk purchased and of the number of adults and children comprising them. For their examination a system of age distribution has been based on that of the Technical Commission of the Health Committee of the League of Nations, whereby individuals over fifteen years of age are regarded as adults and children are classified into groups of two to fifteen years, one to two years, and under one year of age.

The data are summarized in the following Table I, in which the quantities of milk are given in pints per day.

TABLE 1

HOUSEHOLDS WITHOUT CHILDREN

	Number	Milk	Adults
		Pints	
Nairobi	263	626·82	619
Mombasa	66	140·58	159
Country	39	121·29	80

HOUSEHOLDS WITH CHILDREN

	Number	Milk	Adults	2–15 years	Children 1–2 years	Under 1 year
		Pints				
Nairobi ..	162	656·33	401	223	25	18
Mombasa ..	27	80·50	57	27	6	3
Country ..	37	261·75	101	66	7	5

In those households in which there are no children the average amount of milk used per adult per day is for Nairobi 1.012 pints, for Mombasa 0.884 pint, and for the country 1.516 pints. Each of these figures is above the minimum amount of 0.5 pint per day recommended for an adult in a memorandum from the British Ministry of Health, but the same authority has suggested no optimum amount for adults.

If, however, we consider the results of a recent survey[1] of the relationships between food, health and income in Britain and assume that the individuals in the two highest income groups in that survey are receiving an adequate food supply we may conclude that the amount of milk contained therein approaches the optimum. For these groups the average per head per day is 0.71 pint. This, of course, will be weighted by the number of children in the groups examined, but since the averages for the three areas under consideration in Kenya all exceed 0.7 pint they may be considered adequate.

For the households with children the same difficulty in establishing an optimum for adults is encountered. The Technical Commission, however, has given the amounts required by children of two to fifteen years as 1,000 gms. and by children

[1] "Food, Health and Income", by Sir John Orr (McMillan).

of one to two years as 750 gms. For milk of specific gravity of 1.031 these amounts are approximately 1.70 pints and 1.275 pints respectively. The amount required by infants under one year of age may be taken as an average of 1.5 pints, but a slight variation in this amount will have little effect on the calculations because of the small number of infants concerned.

On the basis of these amounts the estimated requirements of the population under consideration have been calculated and are given in the Tables II to IV.

TABLE II

Adults at 0·5 pint per day: Ministry's minimum. Children 2–15 and 1–2 years at Commission's standards. Infants at 1·5 pints per day.

	Adults	2–15 years	Children 1–2 years	Under 1 year	Total A	Actual Purchases B	$\frac{B \times 100}{A}$
Nairobi	200·5	379·1	31·9	27·0	638·5	656·3	103
Mombasa	28·5	45·9	7·7	4·5	86·6	80·5	93
Country	50·5	112·2	8·9	7·5	179·1	261·8	146

TABLE III

Adults at 0·7 pint per day: British Survey. Children 2–15 and 1–2 years at Commission's standards. Infants at 1·5 pints per day.

	Adults	2–15 years	Children 1–2 years	Under 1 year	Total A	Actual Purchases B	$\frac{B \times 100}{A}$
Nairobi	280·7	379·1	31·9	27·0	718·7	656·3	91
Mombasa	39·9	45·9	7·7	4·5	98·0	80·5	82
Country	70·7	112·2	8·9	7·5	199·3	261·8	131

TABLE IV

Adults at rate of those in households without children. Children 2–15 and 1–2 years at Commission's standards. Infants at 1·5 pints per day.

	Adults	2–15 years	Children 1–2 years	Under 1 year	Total A	Actual Purchases B	$\frac{B \times 100}{A}$
Nairobi	406·2	379·1	31·9	27·0	844·2	656·3	78
Mombasa	50·4	45·9	7·7	4·5	108·5	80·5	74
Country	153·1	112·2	8·9	7·5	281·7	261·8	93

Conclusions

If it can be accepted that all of the milk purchased by those making returns is consumed by the individuals recorded as constituting the households, the following conclusions are reached: —

1. Adults in those households in which there are no children are receiving adequate supplies when comparison is made with the British Ministry of Health minimum and with the amount consumed by the groups of the population in Britain whose nutrition approaches the optimum.

2. In those households in which there are children—

(*a*) the consumption in Nairobi, Mombasa and the country are respectively 103, 93 and 146 per cent of the estimated requirements on the basis of the British Ministry of Health minimum of 0.5 pint per adult per day;

(*b*) the consumption in these areas are 91, 82 and 131 per cent of the estimated requirements on the basis of 0.7 pint per adult per day, the amount found during a British survey to be consumed by those groups of the population whose nutrition approaches the optimum;

(*c*) the consumptions in these areas are only 78, 74 and 93 per cent of the estimated requirements on the basis of the amounts for adults which the present survey has shown to be purchased in households with no children.

3. In households with children an increase in the consumption of liquid milk amounting to at least 10 per cent, and possibly to as much as 25 per cent, is an ideal to be aimed at.

Diseases of the Cow's Udder*

VARIOUS FORMS, AND THEIR TREATMENT

By I. P. MARAIS, *Veterinary Research Officer, Onderstepoort*

From an economic point of view udder troubles constitute the most important group of diseases to which milch cows are subject. Apart from the possibility of certain forms of a disease proving fatal, additional factors to be taken into consideration are the drop in quantity and quality of milk obtained, depreciation in value on account of permanent injury to the udder, the tendency towards repeated occurrences of the disease and the danger of injury to the consumer's health.

NATURE AND STRUCTURE OF THE UDDER

On account of the excessive development of the milch cow's udder, the protection afforded to it by virtue of its position is not as effective as in the case of other mammals producing only sufficient milk for their young. The udder consists of soft tissue, richly supplied with blood, its outer covering being only a thin skin, and it is constantly exposed to wounding and bruising. When a cow lies down, her udder and teats come in contact with the bedding and animal excretions containing millions of germs, some of which may cause infection and inflammation. For this reason the cow should be provided with good, clean bedding, and her stall should be so constructed as to minimize contamination of her bedding. Normal live tissue is very resistant to infection which may cause inflammation, but bruised or half-frozen tissue is more susceptible. See to it, therefore, that there is sufficient good, soft bedding for the cows to lie on, especially where they have to stand on hard floors.

The udder is composed of four quarters; the left and right halves are separated by a fairly dense connective tissue partition. There is no perceptible partition between the quarters of each side, but they are functionally separated, as ordinary inflammation arising in one quarter cannot be transmitted to the other directly.

Each quarter consists of glandular tissue where the milk is secreted. Milk is formed in minute cavities, invisible to the naked eye, from which it flows along very fine ducts, which are joined by other ducts, like innumerable branches of a tree, until they reach the lactiferous sinus situated at the upper end of the teat. The teat canal is not in reality an open space, being normally closed by swollen veins and at the extremity by a circular band of muscle tissue. The blood is conveyed to the udder by the mammary artery, which enters at the top near the centre and cannot be felt from the outside. The milk vein is the one which conveys the blood from the udder after the constituents required for the manufacture of milk have been extracted. It has therefore no connexion with the supply of blood or milk to the udder.

In the udder tissue there is an enormous number of veins which together can contain half the total volume of blood of the body. All the tissues of the udder are exceptionally elastic and able to exert pressure on the small lactiferous sinus.

From this short summary of the composition of the udder, we may deduce certain facts which are of importance in connexion with the normal functioning and the diseased conditions of the udder. Owing to the partitions between the quarters, it is possible for infection and

*Reprinted from *Farming in South Africa*, Vol. XII, No. 140.

inflammation to remain confined to one quarter only. Contrary to what was previously assumed, we now know that an udder can hold more milk than can be drawn out at one milking. The quantity of milk in the udder is limited by the degree of elasticity of the organ and as soon as the pressure reaches a certain point, milk secretion ceases. When the udder and teats are handled by the milker, or when the calf begins to suck, an erection of the udder tissue takes place which forces the milk from the small sinuses and tubes, enabling it to flow. The process is under the control of the nervous system and when the cow is affected by pain or fear, this so-called reflex action does not take place, the result being that the cow does not release her milk.

Wounds and Bruises of Udder and Teats

Bruising of the udder and teats frequently occurs unnoticed. It is one of the causes of *blood-stained* milk, and may lead to inflammation of the udder by decreasing the resistance of the tissues. When bruising is recognized through change of colour on unpigmented skin, swelling, heat and pain, or traces of blood in the milk, it should be treated with care, to avoid more serious consequences. Bathe the bruised portion with lukewarm water a few times every day, stripping the quarter on each occasion.

Wounds.—Superficial wounds of the teats should be thoroughly cleansed and disinfected with 70 per cent alcohol or methylated spirits. The same applies to lesions of skin diseases, such as cow pox, appearing on the udder. The scabs which form on the teats generally crack when the latter are pulled. Before milking, rub the affected teats with a non-irritating ointment, such as zinc ointment or zinc-tar paste.

Cracked teats usually occur during the cold months, and are treated in the same manner. They may be avoided to a great extent by dry-milking.

Deep wounds of the udder or teats, extending right into the gland, the lactiferous sinus or the teat canal, are of a more serious nature, and treatment will, as a rule, prove successful only if the cow is dry. Such a wound, from which milk is discharged, is known as a milk fistula.

A wound on the udder should be thoroughly cleansed, disinfected with iodine or some other strong antiseptic, and then smeared with iodine ointment or zinc-tar ointment. Shallow open wounds of this description may become separated from the glandular tissue, and heal out if they are kept clean. Deep puncture wounds frequently contain foreign matter, such as earth or a piece of wood or straw, and not only will such wounds take longer to heal, but they may lead to serious inflammation of the quarter and even to gangrene, which may prove fatal. Where deep puncture wounds are concerned, it is advisable to call in professional assistance. If this is not available, the affected portion of the udder should from the outset be washed in hot water for half an hour or longer four or five times daily, the affected quarter being milked dry on each occasion. The injury may result in the formation of an abscess, which is to be regarded as a favourable development, or a permanent fistula may remain, which does not heal or develop any further. For the treatment of such a fistula, the help of a veterinarian should be enlisted, as an operation will be necessary. Even then the chances of success are slight, unless the cow is dry. In the case of high-producing cows, the desirability of destroying the secretory powers of the

quarter should be considered. The remaining three quarters will yield more and almost make good the loss. As soon as the cow is dry, the udder will heal under the usual treatment.

A fistula of the teat canal or milk duct can only be treated by a veterinarian. The wound should be stitched with fine suture material as soon as possible and under the strictest aseptic conditions. At the same time the teat canal should be held open by means of an instrument, to prevent it from closing and milk from flowing through the wound. If it is economically possible, the cow should be dried off without delay, for even under ideal conditions it is very difficult to effect a cure during lactation.

Warts on the Teats

These may be troublesome and lead to serious sores. They are also infectious, and may be carried from one cow to another by the hands of the milker. Rub the affected teats daily with a mixture of 3 per cent salicylic acid in castor oil, until the warts have disappeared entirely.

Udder Abscesses

These are caused by wounds which have become infected with pus-producing organisms. The formation of abscesses is a sign that the powers of resistance of the udder tissue have withstood the spread of the infection and isolated the suppuration from the healthy tissues. Abscesses should be opened as soon as they have come to a head, i.e. when they show a soft, fluctuating centre. The opening should be made at the lowest point of the soft spot, to enable the pus to run out freely. Do not allow the pus to drop on the floor of the stable. Irrigate the abscess cavity with a disinfectant, and fill it with iodine ointment or zinc-tar paste.

The udder should be kept free from ticks. Make regular use of the dipping tank, and apply tick oil to the udder, between the thighs, etc., where the ticks are lodged. Ticks, especially the "bont-poot" variety, constitute an important cause of udder abscesses. This variety has long mouthparts which penetrate deeply into the skin. They should not be pulled off, but smeared with paraffin or tick oil, and allowed to drop off.

Occlusion of Teats

Occlusion may be caused in various ways, viz. (1) coagulations of milk, which occur in certain forms of inflammation, but which may also occur in otherwise normal udders; (2) calculi; (3) by a wart on the wall of the teat duct; (4) thickening of the wall of the teat duct, as a result of injury; and (5) by a membrane growing over the canal.

Milk clots may usually be removed by continually milking at the teat. If this does not prove successful, the teat may be syringed with a little olive or almond oil which has previously been boiled. Should this not produce the desired result, the teat will have to be opened by means of a special instrument. Unless the farmer has had experience of this, it is advisable to call in the assistance of a veterinarian. *The inexperienced should rather allow the quarter to dry up than attempt an operation themselves.* All instruments, as well as the syringe, should be boiled for at least ten minutes and kept in 70 per cent alcohol. The teat and neighbouring parts, as well as the hands of the operator, should be washed well with soap and hot water and then disinfected with 70 per cent alcohol.

Calculi consist of calcium salts occurring in the milk. They may be distinguished from milk clots by the fact that they feel much harder and are not easily dislodged. The treatment prescribed above may be applied, except that the

teat should not be opened by piercing, but the calculus should be removed by operation if injections of oil do not dislodge it.

Warts are cut out by means of a special instrument which is inserted into the canal beyond the obstruction. After the operation the canal is held open by means of a metal tube, to prevent it from closing.

Thickening of the wall of the canal may impede the flow of milk. The canal is widened by inserting into it teat siphons of gradually increasing diameter, or else by inserting a few threads of cat gut which swells when it becomes wet, thereby stretching open the canal.

Membrane in the teat canal.—The removal of a membrane blocking the teat canal involves an operation, and can only be performed by a veterinarian. In some cases it is possible to open up the stoppage by using a special teat instrument. Strict sterilization must, however, be carried out when this method is employed. If the stoppage occurs at the tip of the teat, the milk is forced up against the stoppage, and with a sharp sterilized knife a cross is cut over the tip until the milk flows out.

Changes in the Milk

Blood-stained milk is generally the result of (1) bruising or inflammation, when it is confined to the affected quarter or quarters; (2) a sudden increase in the supply of blood to the udder, such as occurs when milch cows are suddenly transferred from the veld to an abundant, rich ration. The presence of blood continues at most for a day or two, and is apparent in all the quarters; (3) redwater, the first signs sometimes appearing in the form of a slight reddish discoloration of the foam; (4) oestrum or heat, which may have this effect on some cows; and (5) cracked teats, new growths in the glandular tissue or the lactiferous sinus, and tubercular lesions, which may lead to occasional traces of blood in the milk from one teat. Some writers also contend that the ingestion of certain plants may cause blood-stained milk, but there is no proof that such plants exist in South Africa.

Treatment will depend upon the cause. The treatment of bruises has already been described, and inflammation will be discussed at a later stage. Great difficulty is often experienced in ascertaining the cause. In the case of a slight chronic inflammation the affected quarter is harder and frequently larger than the other quarters. Haemorrhage may be continuous or intermittent. In the case of tuberculosis or other causes which lead to the formation of ulcers, haemorrhage is often intermittent, but continues for long periods until the ulcer has healed, and may occur again with the development of fresh ulcers. In many cases the quarter shows no other changes. New growths can usually be felt in the form of hard lumps in the quarter. In order to determine the cause, samples of milk from the affected quarter may be sent to the veterinary laboratory at Onderstepoort for examination, together with a description of the condition.

Blue milk.—Watery milk has a blue colour, and in some forms of inflammation in which the milk becomes watery it has a greyish-blue appearance, but there is also a specific germ which may cause blue discoloration of milk. The germ may find its way into the milk from the surroundings, or may occur in the udder itself. To prevent infection from without, the milk pails and the hands of the milker should be thoroughly disinfected. The udder should be well washed, and the milk covered immediately. If the infection occurs in the udder, it may be

combated by syringing into the teats a mixture of two teaspoonfuls of sodium thiosulphate ("hypo") to a pint of water. The udder should be stripped frequently. What has already been stated in connexion with operations on the udder, viz. that the inexperienced are not advised to attempt them, also applies here.

Dropsy of the Udder (Oedema)

The swelling of a cow's udder which occurs normally before calving, may occasionally be so serious as to cause the owner some anxiety. It is apparent in all the quarters, and the swelling may extend from the vulva to the front of the chest. It disappears of its own accord within a day or two after calving. The swelling is comparatively cool, and is doughy to the touch.

This condition will pass over more rapidly if the cows receive sufficient exercise, are not given a heavy ration just prior to calving, and the bowels are kept active by providing sufficient green feed and good hay. In the byre the cow should not be allowed to stand in a draught, and should be supplied with sufficient good, clean bedding. If the swelling is exceptionally bad, relief may be afforded by bathing the udder with hot water and stripping it a few times before calving. If the condition persists after calving, and the udder does not return to normal, treatment must be applied. Bathe the udder with lukewarm water for at least half an hour four or more times daily. This may be carried out by placing a basin of hot water under the animal; a towel or a clean bag is dipped into the water, and two men, one on either side of the cow, hold it against the udder until it is cool, when the process is repeated. The udder is now stripped; the discharge obtained will vary from a thin blue, watery liquid to thick lumps. When the udder is empty, it should be rubbed with camphor oil, olive oil or soap, and massaged. If the treatment is carried out thoroughly, the condition described should not last for more than a day or two. A suspensory bandage for the udder, fastened over the back and under the tail, is of great value in treating all forms of udder inflammation. Since it is difficult to keep the bandage in position, it requires a certain amount of experience to do it successfully.

Oedema after calving occurs normally in a greater or lesser degree in all cows. If it does not readily disappear of its own accord and is not carefully treated, it may lead to serious inflammation of the udder, on account of the increased susceptibilty to infection of the udder when in that condition.

Inflammation of the Udder

There are various forms of inflammation, differing in degree and course. The form is determined by the nature of the causal organism. The causes of all forms are *bacteria* and sometimes other organisms gaining entrance to the udder under certain circumstances, and multiplying there.

The external conditions predisposing to infection may in most cases be avoided. Bacteria and other germs develop rapidly in dirty, wet and dark places. Care should therefore be taken that the stalls are kept clean and dry and exposed to the sunlight as much as possible, as sunlight destroys most germs. The bedding should be exposed to the sun every day. Other circumstances which should be avoided are animals with abscesses, open sores, or purulent discharges from the womb after calving. Such animals should not be allowed to come into contact with milch cows, but be isolated until they have recovered. If an abscess discharges in the stable, millions of germs, which may cause

inflammation, are deposited on the floor, and it is of comparatively little value to wash the floor with a bucket of water or even a disinfectant fluid. The same applies to the other conditions.

A healthy udder has great powers of resistance against infection, but bruising, wounding, extreme changes of temperature and dampness reduce the natural resistance and render the udder more susceptible to infection with the organisms present. A large, tense udder, as in the case of high-producing cows, is more exposed to these conditions, and consequently such cows suffer more frequently from inflammation of the udder.

Acute Inflammation of the Udder

The characteristics of this disease are a sudden swelling in one or more quarters of the udder, together with heat, pain, and changes in the milk. The symptoms depend upon the degree of severity of the disease. The milk may vary from almost normal to a watery liquid, there is no unpleasant odour, it rarely contains traces of blood, but it usually flocculent. The affected quarter is stiff, hard, painful and appreciably hot.

General symptoms will also be observed, except in very light attacks. There is fever, loss of appetite, trembling and stiff gait and, in more serious cases, unconsciousness, and it may prove fatal.

In light cases the animal may recover without treatment. It may, however, develop into other more dangerous forms or result in permanent hardening of the udder.

Treatment should be carried out regularly and with care. Bathe the affected portion in lukewarm water for half an hour four of five times every day, stripping the teat on each occasion, not on to the floor, but into a bucket which can be disinfected. In treating valuable cows, an antiphlogistine poultice, or a poultice of some other similar preparation, and a suspensory bandage may be put on overnight. In no circumstances should the quarter be rubbed, as this will cause the condition to spread to the healthy parts. If treatment is carefully carried out, the condition seldom persists for more than three days. Continue the treatment until the milk is quite normal in appearance and taste. Keep the cow warm and in a clean place, and feed her principally on soft, easily digestible food, such as bran, oatmeal and green feed. In the early stages a purgative consisting of 1 lb. of epsom salts with $\frac{1}{2}$ lb. of common salt should be given. Some persons also recommend a dose of 1 oz. of sodium thiosulphate ("hypo") or $\frac{1}{8}$ oz. of carbolic acid (phenol) together with the purgative.

Necrotic Mastitis

Another form of acute inflammation which is more dangerous and often fatal, is the so-called necrotic inflammation of the udder, which also occurs in sheep, when it is known as *blue udder*.

Cause.—It is caused by virulent bacteria, which destroy the udder tissue, and is frequently the result of deep puncture wounds and the insertion of unsterilized instruments into the teat canals.

Symptoms.—The condition is characterized by the usual signs of acute inflammation, swelling together with heat and pain, and the secretion of a thin, brown fluid containing traces of blood which has a most unpleasant odour. The glandular tissue is destroyed, and the process may spread to the other quarters. The animal may die in the early stages from blood poisoning, or the quarter may waste away. Occasionally it develops into gangrene of the quarter, the skin becoming dark red or black; later the quarter becomes separated from the healthy tissue, eventually sloughing out. This sequence of events is normal in sheep,

but the whole course is seldom completed, as both sheep and cattle usually die of blood poisoning in the early stages of gangrene. If the animal recovers, the affected parts are irreparably destroyed.

The general symptoms as already described are more severe.

Treatment.—Remember that the disease is most infectious, and ensure that treatment is not carried out in the presence of other cattle. Other cows should not be milked by anyone who has just treated an infected animal. The same methods of local treatment are applied, but they should be carried out more frequently and for longer periods. It is important that the udder be continually washed and stripped. For this form of infection, irrigation with suitable disinfectants may be recommended. Non-irritating substances such as flavine, rivanol and certain dyes, e.g. pyoktanin, brilliant green and others, are used. Irrigation is carried out through the teat canal, using the necessary instruments and taking the precautionary measures previously described, and should only be undertaken by an experienced person. The general treatment is the same.

Chronic Inflammation of the Udder

This disease appears gradually, in the form of a swelling of the udder, accompanied by little or no heat and pain. There are various forms of chronic inflammation.

Common Catarrh of the Udder

This is a light form of inflammation which may occasionally be the forerunner of a more serious form of chronic inflammation.

Symptoms.—Watery milk with floccules, forming a sediment if the milk is allowed to stand for some time; the milk has a salty flavour. The latter symptom is always present, and is usually the first to show. The udder itself shows few changes. Sometimes the affected quarter is slightly harder and larger than normal. The easiest method of recognizing the condition is to milk into the hand a little milk and taste it, in order to ascertain whether it has a salty flavour.

Treatment.—If the udder is frequently and carefully bathed with hot water and milked dry, success will almost invariably be achieved. At the same time it may be rubbed with a stimulating ointment, such as camphor and turpentine ointment.

Purulent Inflammation of the Udder

This is caused by a specific bacterium, viz. a streptococcus, is very infectious and is the most common form of udder inflammation. It is usually a sequel to another form of inflammation, especially catarrah, and is characterized principally by the milk changes. The milk gradually becomes thinner and more watery, it is flocculent and changes to a yellow or brown watery liquid full of grey specks. The udder is usually hard and tense, but when the condition persists for long it becomes smaller, is usually flabby, and the secretion is a thick, yellow pus.

The usual method of transmission is by the hands of the milker, particularly in the early stages, which are frequently not recognized. By this means it extends to the healthy quarters, the whole udder frequently becoming affected.

Treatment.—The usual treatment as already described may be applied. It is essential to isolate animals so affected, and to take good care that the secretion from the udder does not come into contact with the floor, hands, clothes or implements. Milk the cow into a separate bucket containing a disinfectant. Irrigation is of importance in combating the disease, but should only be applied on the advice and under the supervision of a veterinarian. General treatment and dosing may also be tried.

If in spite of treatment the condition still persists after a week, the udder or the affected quarters should be dried off. If this is done a few months before the following calving, the affected quarters will, in the majority of cases, recover completely and yield normal milk during the following lactation period.

Tuberculosis of the Udder

Tuberculosis is a generalized disease, the control of which cannot be discussed here. The udder is frequently infected with the formation of characteristic lesions of the disease in the glandular tissue. Initially the milk shows no noticeable changes; later on a chronic catarrh of the udder develops, which does not improve with treatment. The milk becomes yellow, with grey floccules, occasionally showing a light green tinge. The udder becomes enlarged and tense, and has an *uneven surface*. In cases of tuberculosis of the udder, millions of tuberculosis germs are discharged into the milk, the disease thereby being transmitted to calves and human beings, especially children. Even if the udder shows no sign of disease, or only a light catarrh, the milk may contain the germs and spread the disease. Where tuberculosis is suspected it is therefore advisable to send specimens of milk to the nearest veterinary laboratory, for examination.

Treatment.—As soon as the disease has been diagnosed, affected animals should immediately be killed and burned.

Actinomycosis of the udder is caused by a fungus, which is also responsible for "wooden tongue" and a swelling with suppuration of the jawbones. The udder lesions resemble those of tuberculosis, excepting that ulcers and fistulae form on the udder, and the discharge is watery and of a greyish black colour. Such animals should be killed.

Summary

The most important diseased conditions of the udder have been briefly described, preceded by a short description of the composition and function of the udder. In brief, the types of inflammation may be recognized as follows:—

(1) Udder swelling before or directly after calving; doughy without heat or pain—*oedema*; not dangerous. Afford relief by milking the udder a few times, spray or bathe it with lukewarm water, and massage it.

(2) Udder swelling which originates suddenly; hot and painful, general symptoms, with watery milk—*acute inflammation*. Bathe the udder with hot water for extended periods as frequently as possible; poultice the udder, and use a suspensory bandage. Do not massage. General treatment.

(3) As in (2), with milk brown or containing traces of blood and frequently having an unpleasant odour—*necrotic inflammation*. Where development has reached an advanced stage, recovery is impossible. Avoid pressure or massage in any form. Treatment as for (2), together with irrigation.

(4) Udder swelling which develops gradually wthout heat or pain; salty taste in the milk, which later becomes watery and flocculent—*catarrh*. Strip continually, and apply hot fomentations.

(5) Same as (4), on a more serious scale. Pus in the milk—*purulent inflammation*. Apply usual treatment with irrigation, and if recovery does not follow, allow the cow to dry off.

Preventive Measures

The prevention of udder diseases may be summed up in one word, cleanliness.

(1) Isolate infected cows, and prevent contact, whether direct or indirect, with other cows.

(2) Badly infected cows and those which repeatedly become infected, should be done away with.

(3) Examine the cows regularly for the first signs of udder disease; isolate them and treat them during the early stages.

(4) When buying new cows, ensure that the udders are in a healthy condition, and that the cows do not come from herds with many cases of blind teats or affected udders.

A Note on the Poison Bait used for Rodents in the Kilosa District of Tanganyika Territory

By J. ROBERTSON, *B.Sc. (Agr.), A.I.C.T.A., Agricultural Officer, Tanganyika Territory*

The field mouse (*Mastomys coucha*) assumed epidemic proportions in the Kilosa district of Tanganyika Territory in 1931, and although the outbreaks since then have varied in intensity this pest has caused a considerable amount of damage from year to year. In this district various methods of combating this rodent have been employed, e.g. gassing by sulphur dioxide, poisoning by arsenical compounds, and trapping by wire and water traps. At the present time reliance is placed entirely on the use of barium carbonate bait. Its success and the ease and safety with which it may be used has prompted this note.

Round Kilosa the field mouse usually begins to breed in March and April in its natural habitat, the grass bush, and continues there until the height of the dry season, when natives are accustomed to fire the grass. The result is that the rodents are driven into cultivated land. There the readily available food induces rapid breeding, so that litter after litter of young is produced and standing crops (especially cotton) are quickly damaged. The position is aggravated by the fact that natives leave their cut sorghum crops in the field to dry, a custom that encourages rats considerably, since they have access to a practically unlimited supply of food. Later, when the sorghum crop is removed to native houses, the rodents turn their attention to the cotton crop.

In 1937 with the effective co-operation of the Administration, action was taken to stop bush fires and thus reduce the migration of the rodents into cultivated land. It was realized that prohibition could not be completely effective in one year, especially as native custom in this respect is so bound by convention; but what grass fires there were occurred so late in the season that the sorghum harvest was over and the bulk of the cotton picked before the migration from the bush to cultivated land took place. Also the fact that food is not so readily available in the bush precludes rapid breeding.

The bait now employed exclusively is one part of barium carbonate in three parts by volume of maize meal. These are thoroughly mixed and made into a stiff porridge by the addition of boiling water. Adequate stirring is essential to avoid lumps and the mixture when ready should be so thick that it can be stirred only with difficulty. This porridge, when cool, is made up into balls of a convenient size, e.g. about one inch in diameter and in the process of being made up is mixed with maize offal, so that the latter is mixed throughout, as well as being coated on the outside of the balls. There is no need to cook the maize meal as is often supposed; the addition of boiling water gives an equally attractive medium, while the fact that it is extremely easy to burn the maize meal during cooking is a further reason against it. The balls of prepared bait are placed in rat-infested lands, if rainfall is heavy under a shelter of grass or banana leaves. The bait may also be used in houses since it has been found to be equally effective against house rats. The essential point is that baiting should commence as soon as an outbreak is detected, so as to kill off pregnant females as early as possible. It has not been found necessary to give the prepared bait a distinguishing

colour since barium carbonate is harmless to live stock, at least in the small amounts present in the baits.

The maize offal mentioned above is the material removed in the pounding of maize in a mortar in the preparation of maize flour. Normally the outer seed coat removed in the first pounding is thrown away and the offal used in the bait is the waste material derived from the second and third poundings in the mortar. This material also may be discarded although it may be dried and used in the manufacture of native beer and in times of hunger as food. It is composed of the outer coats of the maize grain (Swahili: *pumba*) plus a certain amount of maize germ (Swahili: *chenga*) removed in the process of pounding. This material if set aside for a day or so, instead of being dried, develops a peculiar odour and flavour which seem to be particularly powerful in attracting rodents. It has undoubtedly been the turning point in the success of the rat-poisoning campaign conducted here in 1937. Other attractants which have been used are groundnut oil, sesame oil and dried fish, none of which were as effective as the maize offal; further, the fact that this is a waste product is an important aid in popularizing the method.

At Kilosa the maize meal and maize offal are supplied by natives and the bait prepared on the spot by paid employees previously trained in this work. Direct issue of barium carbonate to natives, together with instructions does not produce the required results since the ordinary native will not take the trouble to prepare the bait properly. Non-natives receive barium carbonate together with instructions for the preparation of the bait.

The bait described above is not to be regarded as a panacea for overcoming all the difficulties of rodent reduction. It has proved highly successful in this district in counteracting a menace which for several years reached epidemic proportions. The effectiveness and availability of the attractant used warrant its trial elsewhere.

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[1] Harris, W. V. (1934).—"Rats and Mice," Tanganyka Dept. Agric., Entom. Leaflet No. 12.

[2] Harris, W. V. (1937).—"The Grey Field Mouse," *East African Agricultural Journal*, Vol. II, No. 4.

The Relation of Game to Agriculture

By S. P. TEARE, *Game Warden, Tanganyika Territory*

A cultivated crop has an attraction to some varieties of game animals, particularly as it is often the only succulent food available when the rest of the country is dried up.

Elephant are the most spectacular offenders, as in a single visit they can do a great deal of damage to a banana grove, a patch of millet or maize, or to a plantation of sugar cane. The situation became so serious in Tanganyika that for the past three years the extent of the elephant control scheme instituted in 1924 had to be increased in areas where elephant had congregated adjacent to cultivation. The elephant were so numerous that the only satisfactory policy was to thin them out. Any other method, such as scaring them away with maroons, would not have reduced their numbers. But the regrettably large number of elephant that had to be shot is a matter of considerable distaste to game preservationists. The southern part of the territory is where the elephant population is greatest. The control scheme carried out there has resulted in the elephant being driven into game reserves or to unoccupied dense bush country. It remains now for the game rangers and their native scouts who are the cultivation protectors to guard against the return of the raiders. The chief difficulty lies in the native cultivator's habit of planting his crop in an isolated spot. He cannot or will not realize that protection is not an economic possibility where each small garden is many miles away from another.

Baboons are responsible for constant damage to cultivation during the hours of daylight and pigs during the night. Yet the average native cultivator does not exert himself to any extent to deal with these pests. Various schemes for their destruction have been tried with some local success, but immediately control of the scheme is left to the personal efforts of the natives, interest evaporates. The ideal and most efficient way to rid an area of these pests is by wholesale netting. The sleeping place of a troop of baboon is first located, then a turn out of local natives arranged. The area is surrounded by nets four feet in height and held loosely in position by upright posts. As the baboons attempt to climb over they are speared or clubbed by the waiting natives. Another method is by putting down poisoned bait. This latter is very successful but it requires close European supervision as the poison (white arsenic) might become a danger if left in the hands of irresponsible persons.

The decrease in number of their natural enemy the leopard, due to native trapping consequent on the demand for skins, has no doubt assisted in the increase of vermin. It is not uncommon for a planter to remark that he has several lions or a leopard or two living near his mealie crop and he hopes they will not be disturbed as they keep down the pigs.

Where hippopotamus are numerous and reports show they are causing damage to cultivation, they are dealt with departmentally. In less serious cases a system of low fences is used.

Rhinoceros are at times a source of worry to the European planter, as they trample down his young coffee trees.

Eland have a liking for cotton. Even giraffe have on occasion been seen to strip a cotton plant. Buffalo will raid when the crops are green. The latter are fond of young mealies and the green tops of sweet potato plants. If fires are kept

going and tins rattled during the night, these animals can be kept away, but one finds so often that crops are planted in game country and then left completely unsupervised during the night.

Maroons for frightening away game have been tried with some success, particularly where they are exploded in an empty petrol tin. As they are inexpensive, approximately eleven cents each, it should not be difficult for Native Authorities to buy them. Another native method of protection which is not in general use in this territory, but might well be, is to surround a cultivated area with a net-work of bark ropes, empty tins and gourds are attached which rattle in the wind. Unfortunately the majority of natives are too prone, once Government has helped them, to leave it all to the *Serkali*.

Correspondence

The Editor,

The E.A. Agricultural Journal.

Dear Sir,

I notice in the May issue of your excellent journal an idea for a fencing corner supplied by Mr. Bosch of Nairobi.

I append a sketch showing a fencing corner which I believe is stronger and more lasting than Mr. Bosch's corner.

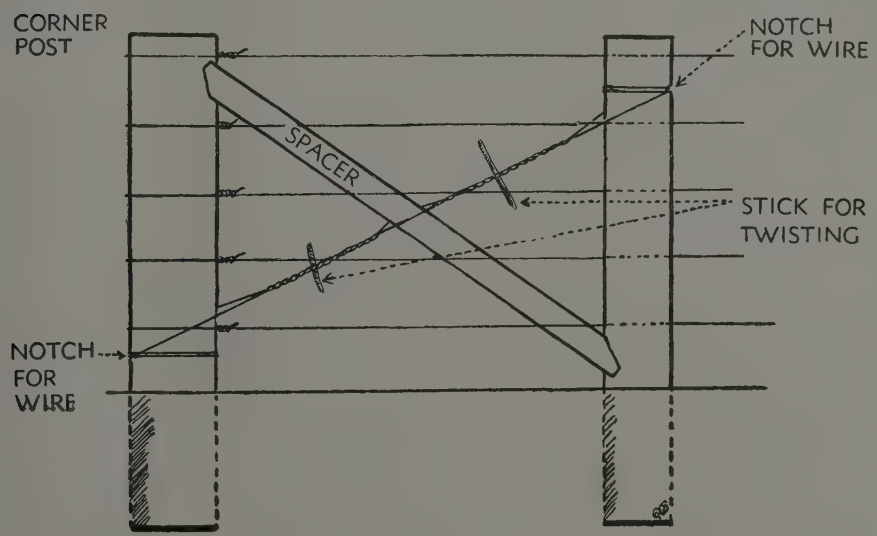
Its advantages are: (*a*) that it eliminates the stone or other "dead-man" and the necessity for digging the hole in which to bury it; (*b*) the anchor wire does not enter the ground and therefore is not likely to rust and break off; (*c*) opposite strands of the anchor wire pass on two sides of the spacer and are twisted together above and below it, thus helping to keep the spacer in place at the same time pulling the two posts together and making the whole "corner" absolutely rigid.

As a rule the spacer need not be larger than 4 in. × 4 in.

Yours sincerely,

L. R. PADDACK

P.O. Box 1464, Nairobi.



Reviews

The Sisal Review

The Sisal Review represents a recent, though not superfluous, addition to the number of trade periodicals in circulation to-day; for many years sisal has ranked as an important article of commerce and hitherto has lacked an organ devoted solely to its interests. Published monthly in London, the new journal reviews current developments in all branches of the sisal industry, under the headings of production, research, manufacture, and distribution. Besides making sisal known to a wider public, the *Sisal Review* should assist towards consolidation and a closer understanding between all partners in this industry, one in which centres of production and of consumption are geographically far removed.

The format of the paper is attractive. As attention is confined chiefly to the products of *Agave sisalana* Perrine, the review has a direct appeal to East African sisal growers, though other fibres also come within its purview in so far as they affect sisal. Interesting contributions have appeared in recent issues on sisal cultivation in Java, research into the adaptation of sisal fibre for possible new uses, spinning machinery, world monetary and exchange problems. The market notes and the statistical appendix are of vital concern for the sisal producer and should be amplified as much as possible.

G. L.

Factors Affecting Spray Success in the Control of Coffee Leaf Disease (*Hemeleia vastatrix* B. and Br.). W. W. Mayne, B.Sc., Mysore Coffee Experiment Station. Bulletin No. 15.

The attention of coffee planters is drawn to this bulletin by W. W. Mayne, of the Mysore Coffee Station, which deals fully with the wide range of research carried out by him on control methods against coffee leaf disease in Southern India.

After a short introduction in which it is pointed out that although the value of spraying is fully recognized, the degree of success has been very variable, due to the fact that no data on the relationships between the disease and climate under South Indian conditions had been collected, the paper goes on to describe fully the study which has recently been made and is divided into four main sections:—

(1) The climate of the area.
(2) The distribution of leaf growth and its variations.
(3) The seasonal development of leaf disease and its variations.
(4) The problem of timing the sprays.

Section (1), describing the climate conditions, states that the area is one of heavy rainfall and that the year falls naturally into four seasons, the characteristics of which are well defined and are closely related to the physiological behaviour of the coffee plant.

Section (2) describes the methods used to determine the relation between climate and the growth periods of the coffee bush. No actual growth measurements were taken as it is pointed out that in dealing with the problems of spraying the distribution of growth, and not the rate of growth, is the important factor. The result of this study showed conclusively that several points connected with the period of growth have a direct bearing on the time of application and the ultimate effect of spraying.

The third section describes fully the effect of climate on the initial sources of infection of the disease and on disease activity. It is shown that the primary factors affecting the start of the disease

are the amount of disease existing at the end of the dry weather and the distribution and frequency of the rains during the hot weather. It appears that the length of the dry weather period is closely related to the later severity of the disease.

In the final section, dealing with the problem of timing the sprays, the observations necessary to determine the correct time of application of the spray under seasonal variations are described, and suggestions are made whereby additional cultural sanitary measures—chiefly in respect of time of pruning—might play an important role. In general it is shown that under South Indian conditions areas carrying a large amount of leaf in the dry weather and those which occur in sheltered situations should be sprayed early; whilst areas carrying little leaf and on exposed sites should sprayed later.

It is only possible in a short review to mention a few of the very important findings made by Mayne in his extensive work on this disease. It cannot be too greatly stressed that spraying programmes must be planned according to climatic and physiological data and not by the calendar. Whether or not it is possible to apply Mayne's specific recommendations to East African conditions must remain a matter for further experiment by coffee planters and by the Agricultural Departments concerned, but the data that he has collected in Southern India clearly indicate the lines on which our study should be directed and will be of material assistance to us in our attempt to solve the same problem in these territories.

In reading this most interesting bulletin, it must be remembered that Mayne is dealing specifically with Leaf Disease (*Hemeleia vastatrix* B. and Br.) and not with "Leaf Fall", spraying against which is so widely practised in Kenya.

S. G.

REPORT OF THE FOURTH INTERNATIONAL GRASSLAND CONGRESS, Aberystwyth, Great Britain, December 1937.

"Over an enormous area of the world grass is the foundation of the agricultural industry, and perhaps almost everywhere it should be the foundation. Grass (and when I say "grass" I mean, of course, grass and clover) properly used, ensures soil fertility, grass marries the soil to the animal and the solid foundation of agriculture is the marriage of animal and soil. That spells humus. While again grass properly employed counters the devastating influences of erosion.

The first necessity is to classify our grasslands, and to understand their interrelations, and then to work and to plan on the basis of clearly defined regions—natural regions.

Soil, climate, grazing animal. Which of these three is the most important factor? Most emphatically the grazing animal! Manure right, sow right and manage the grazing animal wrong and you are nowhere. Without the grazing animal there would be no grassland worthy of the name anywhere in the world. Management is, therefore, the key to the solution of the whole grassland problem. The real point is this, the animal makes for itself its own grassland.

I believe, and I say this not lightly or without experience, that there are many range areas in the world where it would pay best and where more stock could be carried, and that stock in better health, if about three-quarters or more of the area were let go wild and completely unstocked, and if real and tremendous things were undertaken on well-selected remaining areas.

I have said that to ensure soil fertility we need to marry our stock to the soil and the cheapest and most effective way to do this is to plough up all grasslands

that will take the plough at regular intervals. Always before ploughing up, graze as hard as possible for some months, in order to impregnate the soil with urine and excrement. Cash this fertility, or some of it, where you can in a corn or other crop, or sow straight down to grass again, and cash your fertility in more luxuriant grass and build up yet more fertility. Of course, you cannot plough up all the permanent grass, grazings and ranges in the whole world, but with the tractor and modern implements you can plough in all manner of unheard-of places and under all manner of difficult conditions. Manifestly it would be madness to plough up many types of range country, as that would be to invite certain soil erosion, but such is far from true of all range country. And suppose you can establish a thicker sod than ever before, and establish it quickly, and in the non-erosion season.

If the peoples of the world, and to a man, are indeed to be adequately fed with fresh food of the highest quality, and balanced in every respect, then the enormous acreage of the world that stands in grassland of every character, and of no character at all, must be brought to play its full part. It is not only grass itself that is so essential as a feed, but it is the whole acreage under grass that must be made to yield to more intensive treatment. To an ever-increasing extent this acreage must be made to produce better and better grass, and also other necessary crops".

The foregoing paragraphs are abstracted from the stimulating address by the President of the Congress, Professor R. G. Stapledon, with which this report is prefaced.

The publication consists of 486 pages and contains the full texts of all the papers delivered at the Congress which was held at Aberystwyth in July of last year. Thirty-seven countries were represented and seventy-two papers were read. Summaries are given in both English and German.

The papers and discussions, which are also given, cover the whole range of modern grassland research and are arranged in two groups: Plenary Papers, which are of a general nature, and Sectional Papers, which refer to particular aspects of pasture research. The latter are grouped under the following heads: Grassland Ecology, including Range Management; Seeds Mixtures; Plant Breeding, Genetics and Seed Production; Manures and Fertilizers, Soil Aspects of Grassland; Nutritive Value of Pastures, Fodder Conservation; and Pastures, Management, Yields and Economics.

Although much of the subject matter of the papers necessarily deals with the pasture problems of the temperate regions of the world and with methods of managemeent adapted to the more advanced agriculture of industrial countries, there is much in this report which bears upon the grassland problems of East Africa, and, of course, much which deals with questions fundamental to pasture research in general.

In this connexion a number of papers are of especial interest, perhaps particularly in the section dealing with grassland ecology. J. W. Rowland, for instance, in his account of "Some factors influencing range management in the Union of South Africa", discusses the underlying causes which have led to a decline of agricultural prosperity in arid regions of the world, and outlines the approach to the problems which is being made by pasture research in the Union. The interesting paper by W. R. Chapline on "Restoring Range Lands in the United

States", has an important bearing on the urgent problem of control of the natural vegetation in order to combat erosion in East Africa, while the paper on "Natural Revegetation of Abandoned Farm Land in the Central and Southern Great Plains", produced by D. A. Savage and H. Runyon, is of interest in the same connexion. The fundamental considerations discussed by G. H. Bates on "Life forms of pasture plants in relation to grassland management", are of great interest in the study of early utilization of natural vegetation in new countries.

In the other groups there is a considerable number of papers which are significant in regard to this part of the world. The problem of soil erosion and the methods of control being employed in the U.S.A. are further discussed by C. R. Enlow in a comprehensive account which he gives of "Pasture improvement in relation to erosion control in the United States".

Modern research in the conservation of fodder, a subject of particular importance to agricultural development in regions of low and erratic rainfall, is dealt with by a number of the authors. Thus H. E. Woodman discusses "The nutritional aspects of grass-drying", and E. J. Roberts deals with recent progress made in this process and the economic aspect of production, under the heading of "The artificial drying of grass in Britain". A paper of great interest and practical significance on "The losses involved in the conservation of grassland herbage", by S. J. Watson, discusses the technique for the determination of losses and compares the various methods of conservation, while W. Kirsch in an account of "Requisites for the ensilage of green fodder on the farm", discusses different types of silo and the effect of silage upon stock, on the basis of experience in Germany.

The sowing down of pastures in areas of low rainfall is a subject of more than passing interest to East Africa and one on which the experience of the more advanced countries of the Empire, faced with this problem, is of considerable interest and value. In this connexion the paper read by J. N. Whittet, giving an account of research on the subject in Australia, may be selected as an example.

One of the most important aspects of grassland management is that of the provision of adequate proportions of leguminous constituents in the pasturage. Although the problem is beset with special difficulties under the climatic conditions of East Africa, the prominence given to the matter in the report serves to direct attention to the need for continued research in this direction, and a number of the papers which deal with leguminous pasture plants are of particular interest. Such, for instance, are the papers by D. B. Johnstone-Wallace on "The influence of Wild White Clover on the Seasonal Production and Chemical Composition of Pasture Herbage, and upon Soil Temperature, Soil Mosture and Erosion Control", and the account of recent research in Finland on the "Associated Growth of Legumes and Non-Legumes", by A. I. Virtanen. Apart from its bearing upon grassland management, this latter paper gives cause for reflection upon the age-old native practice of mixed planting of crops.

The report is primarily of value as a record for research workers but such is the practical significance of a great deal of the matter contained, that it cannot fail to be of great interest to those concerned with the practical aspect of this increasingly important phase of agricultural development.

The report is obtainable from the Joint Secretaries, Fourth International Grass-

land Congress, Aberystwyth, Great Britain, at a cost of £2. A smaller volume, containing abstracts in English and German of the majority of the papers, is available for Sh. 5. D. C. E.

PYRETHRUM IN KENYA

This is the first complete account of the pyrethrum industry in Kenya, though leaflets on cultivation have been available and articles on drying and harvesting have appeared in the local press and in this journal. In the short space of five years the industry has grown rapidly and now plays an important part in the Colony's agriculture. That Kenya pyrethrum is now well established on the world's markets and enjoys a premium in price over pyrethrum from other producing countries is due to the fact that it is possible to offer pyrethrum with a guaranteed minimum pyrethrin content of 1.30 per cent. Legislation to control marketing and importation of inferior strains of seed and planting material has also played an important part in the development of the industry but perhaps the main factor has been the close collaboration between the farming community and the Department of Agriculture.

Research on pyrethrin content has been undertaken and a full investigation has been commenced. There are evidences that as a flowering flush proceeds there is a gradual increase in pyrethrin content. Jary, at Wye, found a decreasing pyrethrin content with successive crops but the figures given by Beckley do not confirm these observations.

There is still much to be learned regarding the response of pyrethrum to variations in climate. The yield varies according to altitude from 4 to 7 cwt. per acre at 5,500 ft. to 6,000 ft., to 10 to 15 cwt. per acre at 8,500 ft. to 9,500 ft.

The increasing number of pyrethrum growers in Kenya will find this paper of interest and value.

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[1] Beckley, V. A., 1938.—"Pyrethrum in Kenya," Bulletin of the Imperial Institute, XXXVI (I), pp. 31-44.
